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END OF THE BOER WAR.

A great sigh of relief goes up from the civilized world at the close of the Anglo-Boer war, from which, as was to be expected, England has finally emerged entirely victorious with a notable addition to her territory, and in spite of a magnificently gallant struggle by the Boers. It is hard to see that the Boers have lost anything save a liberty which they were not willing to share with anybody else; and it is equally hard to believe that the country will not be more progressive and better governed until that British rule which still remains the ideal among practical governments working out the great modern system of civilization for all races of men. Some time must elapse before South Africa is once again wholly given over to the cultivation of the arts of peace, but meantime a better feeling prevails in all the world's markets, and in the long run that rich new country will need all kinds of supplies in exchange for its gold and diamonds, its feathers, hides and agricultural produce. Much of the material will be electrical, and every sign goes to prove that no small portion of it will be requisitioned from the United States. It has been conservatively estimated that the "Rand," which has produced $300,000,000 in gold, has $3,500,000,000 "in sight." This takes no account of Rhodesia or of the diamond fields, and in itself is sufficient to indicate a large consumption of power plant and machinery, to say nothing of its effect in stimulating the industries of the whole world by its continuous flow into the channels of commerce and finance. There are, moreover, great power transmission enterprises awaiting development in South Africa, and again American practice should have an opportunity to repeat itself on the grandest scale.

FATAL AUTOMOBILE RACING.

We can see no objection to tests of speed where only the lives of the contestants, willing to take the risk, are at stake; but surely nothing can ever be gained by speed trials on public highways, such as those which ended in a deplorable accident last Saturday on Staten Island. There, some trouble with the machine or the track—apparently the latter, but nobody knows—caused the flying electric automobile to break a wheel, swerve, and at an estimated speed of 75 miles an hour smash into a crowd of spectators with such effect that two persons are now dead and many were injured. While the vehicle in question might have gained a splendid advertisement had the test resulted as was hoped by its projectors, we can see nothing to be gained by the art of electric automobilism from such work. The designer of the vehicle, Mr. Baker, has done excellent work in the construction of good runabouts, etc., at moderate prices, but it puzzles us to see where he could expect a large market for his cigar-shaped craft. Nobody would ever ride in such vehicles for pleasure; they would not be allowed to make speed on highways, and the only place for them would be racetracks. The development of high speeds has advantages, but there are none to be secured from terrible accidents like that of last Saturday.

From what we know of the conservative temper of President Shattuck, of the Automobile Club of America, and his executive associates, we do not believe they will ever again be induced to patronize road speed contests; and even if they or other clubs did, the public would not tolerate it. Let the manufacturers then seek improvements in their machines in other directions. There is plenty of room. But just at present the public has too much automobile speeding, and while the outcry is unreasoning in some respects, the National Club can best

subserve its purpose by putting itself squarely in line against disturbers of the welfare of the industry, who are also prejudicing the future interests of the sport.

Naval Conservatism.

One of the significant papers of the recent special meeting of the Institute was Lieut. Powelson's discussion of the voltage employed for the standard equipments of the navy, though perhaps the paper would be more correctly characterized were it denominated a remarkably extended apology for a remarkably indefensible naval policy of the past with respect, in this instance, to service voltage. It reads queerly enough to the lay engineer, long familiar with the advantage, nay, the necessity, of working, so far as possible, along standard commercial lines, and fully awake to the importance of keeping up the voltage. But Lieut. Powelson's paper means much more than a recognition of the most fundamental maxims of the practical electrical engineer, for it denotes the effect of young blood and the modern engineering education on the honorable and venerable red-tape office through which modern ideas in naval equipment had so long been sifted. It implies a spirit of progress that came to the new navy when it had work, and serious work, to do, and rose to the occasion. It has long been a subject of wonder to laymen how a system of power distribution for a modern war ship could be anything else than electrical, since no energy transmitting device is so easily defended and so quickly replaced as an electric cable. But year after year steam and hydraulic pipes and donkey engines grew and multiplied, until it was a matter of wonder that room could be found for the complication. Finally, it appears that the Ordnance and Construction Bureaus arose to the occasion, ammunition hoists and turret-turning gear got a hearing, and were, though with ill-concealed distrust, adopted in a tentative way. They were their own argument, and we fancy that no officer who ever turned an electrically operated turret would willingly consent to the use of anything else. And so the good work has gone on, until now we actually have the strange and eccentric voltage, so long demanded by naval specifications, actually put on the defensive and about to be elbowed out of the way. And incidentally it is most encouraging to see that when at last the change began, the voltage went fairly up to modern practice, instead of settling into that comfortable old half-way house, 110 volts. Really, this is the most significant change of all, for nothing else could so plainly show what some of the pious friends of our youth would have called a "hopeful sign of regeneration." Though it may take many years, the new must some time come and the old eventually disappear. Donkey engines and hydraulic pipes must follow whale oil lamps and join sail power and black powder. Peace to their ashes!

Polyphase Traction Abroad.

The important Institute paper by Mr. De Muralt, the concluding portion of which we print this week, gives a clear perspective of what has actually been accomplished abroad in the development of traction by polyphase motors. We have described from time to time all of the roads mentioned, but it is a good thing to take account of stock and to see the actual present state of affairs. The foreign engineers have been most evidently building roads while we in this country have been talking about the advisability of doing so. It is interesting to note that since the initial road at Lugano, none of the lines built have belonged properly to the tramway class. As we have frequently remarked in these columns, tramway working is not the strong point of polyphase railway motors. We have had in this country sufficient experience with the continuous current, double trolley system to look askance at any scheme requiring double working conductors. The average railway manager is pretty well convinced that troubles arise as the square of some higher power of the number of trolleys, and with some justification thinks that one trolley is quite enough. The later foreign roads are distinctly in the class of special or interurban roads. Several of them are of a character unusual in this country, and had they been built here would quite certainly have been equipped with ordinary continuous current motors fed from rotary converters. The relatively higher cost of copper abroad changes the economic conditions very radically. At prices for apparatus and copper current here, the saving in the cost of working conductors, due to the use of polyphase motors, would not be so material as in Europe. By far the most interesting foreign roads are the Burgdorf-Thun and the Valtellina lines, the latter notable for the prominence given it in the "Inner Circle" arbitration last year. Unhappily, it is not yet in full and regular operation, so that data which might be of very great value are lacking. But it is a case in which polyphase motors give a far greater hope of success than in tramway operation, and should be closely watched by American engineers. The new features in it are of a somewhat radical character, and great advantages are claimed for them, of which we shall know more later.

The paper by Mr. De Muralt shows that in Switzerland there are half-a-dozen three phase electric railways, aggregating about 75 miles of road. Experience in their operation dates from 1895, the time of installation of the earliest. Almost all are heavy grade roads, with light passenger traffic. The power is obtained from waterfalls, and carried by three-phase to the track. In some cases the cars carry transformers, and tap off high-pressure currents from the trolley wires. In the greater number of cases stationary step-down transformers are installed. The car motors are three-phase induction motors, requiring at least two trolley wires for their supply. The paper points out that under certain conditions the continuous-current system is superior to the alternating-current system, while under other conditions the case is reversed. Frequent startings and stoppings with short runs, such as are characteristic of urban railway service, are particularly unfavorable to the alternating-current motor. Such conditions approximate, in fact, to the condition of the electric elevator as an extreme case, and the consensus of opinion at present is that the existing continuous-current motor is distinctly superior to the existing alternating-current motor, both in compactness for a given torque and in average efficiency. Consequently for tramways, the present induction motor can hardly expect to supersede the continuous-current motor, even considering the inconvenience of converters and commutators.

For long-distance running, however, with or without grades, the paper claims that experience shows the alternating-current railway motor to be superior. Here the speed is practically uniform, and best suited to the induction motor. The relative amount of power wasted in starting becomes small, while the simplicity of the system becomes particularly advantageous when many miles of road have to be covered. On down grades the motors are capable of acting as brakes by acting as generators, thus restoring part of the energy to the line, and the system is relatively very flexible under variations in the service. Without doubt there will be a development for the alternating-current traction in this country, as the electric railway acquires higher speeds, and covers greater distances at a stretch. The principle difficulty lies in the way of equipment and standardization. The continuous-current railway is now standard in every detail, whereas a change to the alternating-current motor would involve a material modification in car equipment and in line material. The innovation is, therefore, handicapped by additional cost and delay. Meanwhile it is interesting to watch the experience that is being

gained in Europe, and the trend of development towards the alternating-current railway motor on that continent. Yet there seems no doubt that the ordinary trolley street railway system must continue to be operated by direct-currents, if only for the reason that polyphase motors would require at least double trolleys, and our overhead wiring is already burdensome with single trolleys. If, however, the alternating-current motor becomes standard, the difficulty of providing double trolleys may force the trolley wires in all the cities into underground conduits.

THE EARTHQUAKE AT MARTINIQUE.

A preliminary report from the U. S. Coast and Geodetic Survey indicates that magnetic disturbances manifested themselves on the morning of May 8 at the recording magnetometers of Cheltenham, Md., and Baldwin, Kan. These disturbances are described as tremors in intensity and declination, commencing at 7:54 A. M., referred to, St. Pierre local time, and continuing until midnight of the 9th, and even into the 10th. The amount of the disturbance was from 0.5 to 0.6 millimaxwell, and from 10 to 15 minutes of declination. The town clock at St. Pierre is said to have stopped at 7:50 A. M., so that the commencement of the magnetic disturbance in these United States observatories appears to have been nearly coincident with the eruption which overwhelmed St. Pierre in a few minutes. The disturbance of the sea bottom in the neighborhood of Martinique seems to have broken the submarine cables in several directions. The London *Electrician* reports that the Martinique-Puerto Plata (San Domingo) cable was interrupted on May 6th; while on the 9th there were added interruptions to the cables from Martinique to Guadeloupe, and to Dominica, on the north; also to St. Lucia, on the south. The southbound cables from St. Lucia to St. Vincent and to Grenada were also reported broken on May 9th. Considering the forces brought into play in the rupture of so many submarine cables by changes at the bottom of the ocean, it seems wonderful that the eruptions at Martinique and St. Vincent were not even greater and more terrific than those reported.

PHOTOMETRIC VALUES OF ARC LAMPS.

The third Progress-Report of the committee of the National Electric Light Association on this subject was presented at the recent Cincinnati convention, and contains a number of interesting data. The standard of comparative measurement adopted throughout the report is the Hefner lamp. It is generally admitted that the Hefner lamp is a very imperfect standard luminous source, but, on the other hand, by comparison with standard candles, it is a lamp to be thankful for; so, for the present, until a more suitable and reliable standard lamp can be found, it is well to be content with the Hefner, and it would be a great blessing if we could discard the British candle altogether. If it were not for existing contracts and literature, the British candle might be extinguished without a sigh. In industrial practice, however, the British candle is a fiction that has to be sustained. Professor Matthews fortunately adopts the relation given by the National Bureau of Standards, at Washington, namely, 1 Hefner unit = 0.88 British candle, which means that 1 British candle is 1.136 Hefners.

Comparative tests are recorded for 6.6-ampere enclosed series arc lamps of the direct and alternating-current types. These lamps absorb approximately the same volt-amperes, viz., about 450; but, whereas this represents real power in the direct-current lamps, it only represents about 400 watts in the alternating lamps, whose mean power-factor was 0.88. Unfortunately, the results are compared on the basis of specific hemispherical consumption and not in terms of efficiency or of lumens per watt. The results show, however, that the direct-current lamps gave 46 per cent. more light in the lower hemisphere than the alternating lamps, both types taking 6.6 amperes, and being provided with opalescent inner and clear outer globes. With a shade replacing the outer globe of the alternating lamps, this superiority of the direct-current lamps fell to 13 per cent., or, roughly, to the proportion of watts consumed by the two types, respectively. The 7.5-ampere series alternating enclosed lamps had a slightly lower power-factor (0.83), but consumed about the same amount of power (450 watts) as the 6.6-ampere direct-current lamps, and these two types gave, it would seem, nearly the same amount of light in the lower hemisphere. Some noteworthy experiments are reported upon lamps of different types, all adjusted to absorb 450 watts during the test. The 9.5-ampere series open arc was far the strongest in intensity at 30 deg. dip; but at dips less than 12 deg., the 6.5-ampere series, opal-inner-globe, enclosed arc-lamp gives a greater intensity than the open arc-lamp. This means that although the opalescent inner globe absorbs an appreciable amount of the light emitted by a 450-watt arc-lamp, yet it redistributes the remainder in such a manner that near the horizontal its intensity is superior to that of the open arc-lamp. Consequently, for the illumination of distant objects, as in street arc lighting, the 450-watt series arc-lamp, with opalescent inner globe, is not only more pleasing to the eye, but is also more effective than the 450-watt series open arc-lamp.

The conditions peculiar to street lighting give rise to merit in a definite zone of luminous distribution. That is to say, a street arc-lamp is more effective according to the proportion of the light which it emits in the zone between the horizon and a dip of 30 deg. Above the horizon the light can only illumine trees and houses, with but little advantage to the nocturnal wayfarer. Below 30 deg. the light practically falls into a pool below the lamp, for the nearly exclusive benefit of insectivorous creatures. The opalescent inner globe is an artificial means for increasing the light-giving powers of the street arc-lamp in this valuable zone. In store or factory arc-lamps these conditions are modified, and a more nearly uniform luminous distribution is preferable. For similar reasons, the report shows that with open arc-lamps it is advantageous to raise them considerably above the ground. The mean normal illumination of 9.5-ampere, 450-watt arc-lamps appears to have been increased nearly 60 per cent. by raising them from a height of 15 feet to a height of 40 feet. On the contrary, there seems to be but little advantage gained in general ground illumination by raising the enclosed direct-current series arc-lamps above a height of 15 feet, and an actual disadvantage in raising them above 30 feet.

A curious point urged in this connection is as to the proper definition of street illumination, whether "horizontal" or "normal." The former is the illumination, from the arc-lamp, at any point of a smooth horizontal plane surface at street level. The latter is the illumination from the arc-lamp, at each point of the street, of a small surface tilted so as to be normal, or perpendicular, to the rays incident thereon. To a person suspended in a balloon above the illumined street, the former would probably constitute the criterion of useful illumination. To a wayfarer looking for obstacles in his path, the latter seems to be the preferable criterion. We shall, therefore, consider that the normal illumination produced at a distant point by a street arc-lamp was the quantity to which attention should be directed, and the surface integral of this normal illumination extended over a circular horizontal area at street level, having the lamp over its center, and a radius of, say, 150 feet, might constitute a useful criterion of the commercial value of street arc-lamps. Its value would depend upon the relative distribution of the light, and would increase with the proportion thrown out at a small angular dip. The report as a whole is a most useful addition to the literature of quantitative arc lighting.

The Great Barrington Programme of the Institute.

As already announced, the Nineteenth Annual Convention of the Institute will be held at Great Barrington, Mass., on June 18, 19, 20 and 21, 1902. The headquarters of the Institute will be at the Berkshire Inn, where the convention will be held. Guests will also be assigned to "The Barrington" and the Hotel Miller.

There will be one long morning session each day. One day will be devoted to the steam turbine, with a paper by Mr. Francis Hodgkinson, on the Parsons turbine, and by Mr. R. R. Bowker, or a representative, on the De Laval turbine. The other sessions will be devoted to electric railroading, the education of electrical engineers, and to mathematical and technical papers.

The Presidential Address will be upon the Education of an Electrical Engineer, and papers will be presented by the following members:

1.—"The Function of Series and Shunt Resistances in Lightning Arresters," by Mr. Percy H. Thomas, of Pittsburg. 2.—"A New Photometer for Incandescent Light and Similar Sources," by Prof. C. P. Matthews, of Lafayette, Ind. 3.—"Method of Compounding Alternating Current Generators and Motors, Direct-Current Generators, Synchronous-Motor Generators and Synchronous Converters," by Mr. F. G. Baum, of Stanford University, Calif. 4.—"The New Generating Plants of the Niagara Falls Power Company," by Mr. Harold W. Buck, of Niagara Falls, N. Y. 5.—"The Use of the Cathode Ray to Produce Stationary Diagrams of Alternating Current Waves," by Prof. Harris J. Ryan, of Cornell University, Ithaca, N. Y. 6.—"Formula for Calculating the E. M. F. at Any Given Point on an Alternating Current Transmission Line," by Mr. Maurice Le Blanc, of Paris, France. 7.—"A New Type of Current Tracing Instrument," by Prof. R. B. Owens, of Montreal. 8.—"The Predetermination of Alternator Characteristics," by Prof. L. A. Herdt, of Montreal. 9.—"Notes on Railway Speed-Time Curves," by Mr. C. O. Mailloux, of New York. 10.—"Method of Ascertaining from Dynamometer Car Records the Power Required to Operate the Mott Haven Division of the N. Y. C. & H. R. R. R., and the Relative Cost of Operation by Steam and Electricity," by Mr. B. J. Arnold, of Chicago. 11.—"Commutation," by Messrs. David B. Rushmore and E. E. F. Creighton, of Pittsfield, Mass. 12.—"A Study of the Heating of Railway Motors," by Mr. A. H. Armstrong, of Schenectady, N. Y. 13.—"The Present Status of Electrical Engineering Education in the United States," by Dr. Samuel Sheldon, of Brooklyn, N. Y. 14.—"The Electrical Engineering Courses at College," by Mr. E. B. Raymond, of Schenectady, N. Y. 15.—"Notes on an Experiment with Single-Phase Alternators on Polyphase Circuits," by Mr. C. O. Mailloux, of New York. 16.—"Comparative Acceleration Tests of Steam and Electric Traction," by Messrs. B. J. Arnold, of Chicago, and W. B. Potter, of Schenectady, N. Y. 17.—"The Equipment of an Electrical Engineering Laboratory," by Prof. R. B. Owens, of Montreal. 18.—"Energy Loss in Commercial Insulating Materials When Subjected to High Potential Stress," by Mr. C. E. Skinner, of Pittsburg. 19.—"The electrostatic Wattmeter in Commercial Measurements," by Mr. Miles Walker, of Pittsburg.

The local committee at Great Barrington, under the chairmanship of Mr. William Stanley, is making every effort to provide for the comfort and entertainment of the members and guests. There will be a reception at the Berkshire Inn on the evening of Tuesday, June 17th, followed by an informal dance. Wednesday afternoon, tea will be served at "Brookside," the future home of Mr. Stanley, under the management of the Ladies' Thursday Morning Club. Wednesday evening a lantern slide exhibit with five minutes' talks by various members will be given at the Town Hall. Thursday morning, Dr. Arthur E. Kennelly will lecture before the Thursday Morning Club, in Kellogg Hall. There will also be visits to Kellogg Terrace, the beautiful mansion of the late Mrs. Searles. Thursday evening there will be an assembly, with dancing, at the Town Hall. Thursday afternoon there will be a special organ recital on the magnificent pipe-organ at Kellogg Terrace.

Friday afternoon, by courtesy of the Stanley Electric Manufacturing Company, a special train will take the party to Pittsfield, where the works of that company will be visited, and a lawn tea served at the home of Dr. F. A. C. Perrine. In the evening the Institute will be entertained at the Maplewood as the guests of Mayor England and the Board of Aldermen of the city of Pittsfield. The official programme of the Institute will terminate with the morning session on Saturday, June 21st.

Throughout the convention carriages will be at the disposal of those desiring to drive during the day, or to and from the evening entertainments. Conveyances will also run at regular intervals to the golf links. The roads of Southern Berkshire are fine and adapted to driving, automobiling or bicycling. Members or guests desiring to play golf should bring their outfits.

Manager Bruce, of the new hotel Aspinwall, at Lenox, has extended to the Institute the courtesies of his house for dinner Saturday afternoon, with transportation to and from Lenox station to all who desire to visit this charming resort in the Berkshire Hills. Those who can spare the time will not only enjoy a beautiful trip but may desire to extend their stay over Sunday.

Rooms will be reserved for those attending the convention from the afternoon of Tuesday, June 17th. There will be fifty-eight rooms at the Berkshire Inn and forty-eight rooms at the Barrington. These rooms will be assigned strictly in order of application, except that precedence will be given to past-presidents of the Institute who may desire to attend. On account of the limited number of rooms with private bath it is believed that all these will be occupied by members attending the convention who are accompanied by their wives. These rooms will also be assigned in order of application. The rate at both hotels will be $3.00 for each person, American plan, for rooms without bath, or $3.50 per day for each person in a room with private bath.

Arrangements have been completed for a special train leaving the Grand Central Station, New York City, at two o'clock on the afternoon of Tuesday, June 17th, arriving at Great Barrington about 5:30 P. M. Besides this train, there are also through trains at 9 A. M. and 3:30 P. M. on the New York, New Haven and Hartford Railroad (Berkshire Division.)

The National Electric Light Association and the St. Louis World's Fair.

At the recent National Electric Light Convention a resolution, presented by Mr. James I. Ayer, of Boston, was unanimously adopted, providing that the annual meeting in 1904 of the National Electric Light Association shall be held on the grounds of the Louisiana Purchase Exposition Company at St. Louis, Mo., and that the association will lend its best endeavor to contribute to the gathering of such an electrical exhibit as the industry demands.

Prominent members of the association expressed themselves as being highly desirous of seeing the industrial applications of electricity established on a large scale at the Louisiana Purchase Exposition, and they voiced their willingness to co-operate in any way to secure this end, for the reason that the exposition will have the effect of opening up a great deal of territory now undeveloped electrically, while both the electrical central station managers and the manufacturers are alive to the fact that a proper exploitation will have much to do with extending the use of electrically operated and controlled apparatus and appliances, as well as extending electric lighting in no small degree. It is quite probable that the association will have an exhibit of its own for the demonstration of present methods for measuring and selling electric energy, whether for light or power. This exhibit will be educational in character and be intended to make the general public more familiar with the methods employed by electric companies in keeping their accounts and in making their charges.

Meeting of Canadian Electrical Association.

The annual meeting of the Canadian Electrical Association is to be held at Quebec, at the Hotel Frontenac, on June 11, 12 and 13, with sessions in the Quebec City council chamber. A number of interesting trips and festivities have been provided. The following is the programme of regular exercises:

Wednesday afternoon, June 11.—"The Electrical Equipment of an Ordinary Street Car," by Mr. A. B. Lambe, Toronto, Ont. Evening.—"Development of Arc Lighting Apparatus fro 1810 and 1902, with Special Reference to Modern Arc Light Engineering," by Mr. W. D'A. Ryan, Lynn, Mass. Thursday morning, June 12.—"Arc Lighting," by Mr. C. M. Greene, Lynn, Mass.; "Lightning Protection and the Static Interrupter," by Mr. Percy H. Thomas, Pittsburg, Pa. Friday morning, June 13.—"The Use of Storage Batteries in Electric Distribution Systems," by Mr. A. A. Dion, Ottawa, Ont.; "Electric Suburban Railways," by Ed. A. Evans, Quebec, Que.

New Electric Lighting Plant for Ottawa, Canada.

BY A. A. DION.

OTTAWA, the capital city of the Dominion of Canada, occupies a most advantageous position for the utilization of that form of energy with which nature has so bountifully endowed that country, in its mighty and numerous waterfalls. Mainly built on a commanding bluff overlooking the Ottawa River, the city extends in its western section to comparatively low-lying lands—composed in part of islands linked together by bridges—to the main channel of the river, which divides Ottawa from the city of Hull in the neighboring Province of Quebec. Immediately opposite and between these two cities the waters of the Ottawa drop some forty feet over a rocky ledge into a cauldron-like formation. This is known as the Chaudiere Falls, whose great importance is derived from the immense volume of its waters, rather than from its height. A low timber dam extends across the river just above the falls. About this natural and unfailing source of power are clustered on both sides of the river the principal manufacturing and electrical industries of the district.

On the Ontario side of the main channel there are between the islands two large natural canals, which have been enlarged and improved, and are fully utilized by many power users who have built upon the adjacent lands. From these canals the several electric companies of the city derive their power, the water being taken directly into or led to the various power houses by large open timber flumes.

FIGS. 1 AND 2.—EXTERIOR VIEW OF CENTRAL STATION, AND VIEW OF GENERATING ROOM.

The Ottawa Electric Company was organized in July, 1894, for the purpose of consolidating under one management three other companies previously established for supplying light, heat and power, namely, the Ottawa Electric Light Co., the Chaudiere Electric Light & Power Co., Limited, and the Standard Electric Co. of Ottawa, Limited. After this amalgamation all the stations and plants of the three companies were continued in operation for a time, with but slight changes, but the rapid increase of business which followed

compelled the new company to seek more water privileges wherever they could be obtained most quickly and conveniently. Additional plants were installed from time to time without following any comprehensive plan of extension, so that in 1900 the company found itself operating six different stations within short distances of each other. One of these was equipped with steam and used mainly as an auxiliary to the other stations during those periods of "anchor ice" troubles to which they were more or less exposed during the winter, and also to carry the peak of the load during a part of the dark season. One of the hydraulic stations was used as a "central" and distributing station, all other stations delivering their power to a common distributing switchboard, except the arc lighting station, which was run independently.

On the 26th of April, 1900, Ottawa was visited by one of the most destructive conflagrations in the history of Canada. In the space of eight hours fire had laid to waste almost all of the city of Hull, where it originated, and a considerable portion of Ottawa, including all the manufacturing district, rendering fifteen thousand people homeless and mostly destitute, and destroying millions of dollars of property. The scene which was presented to view when the sun arose over the ruins in the power district was one of extreme desolation. Few

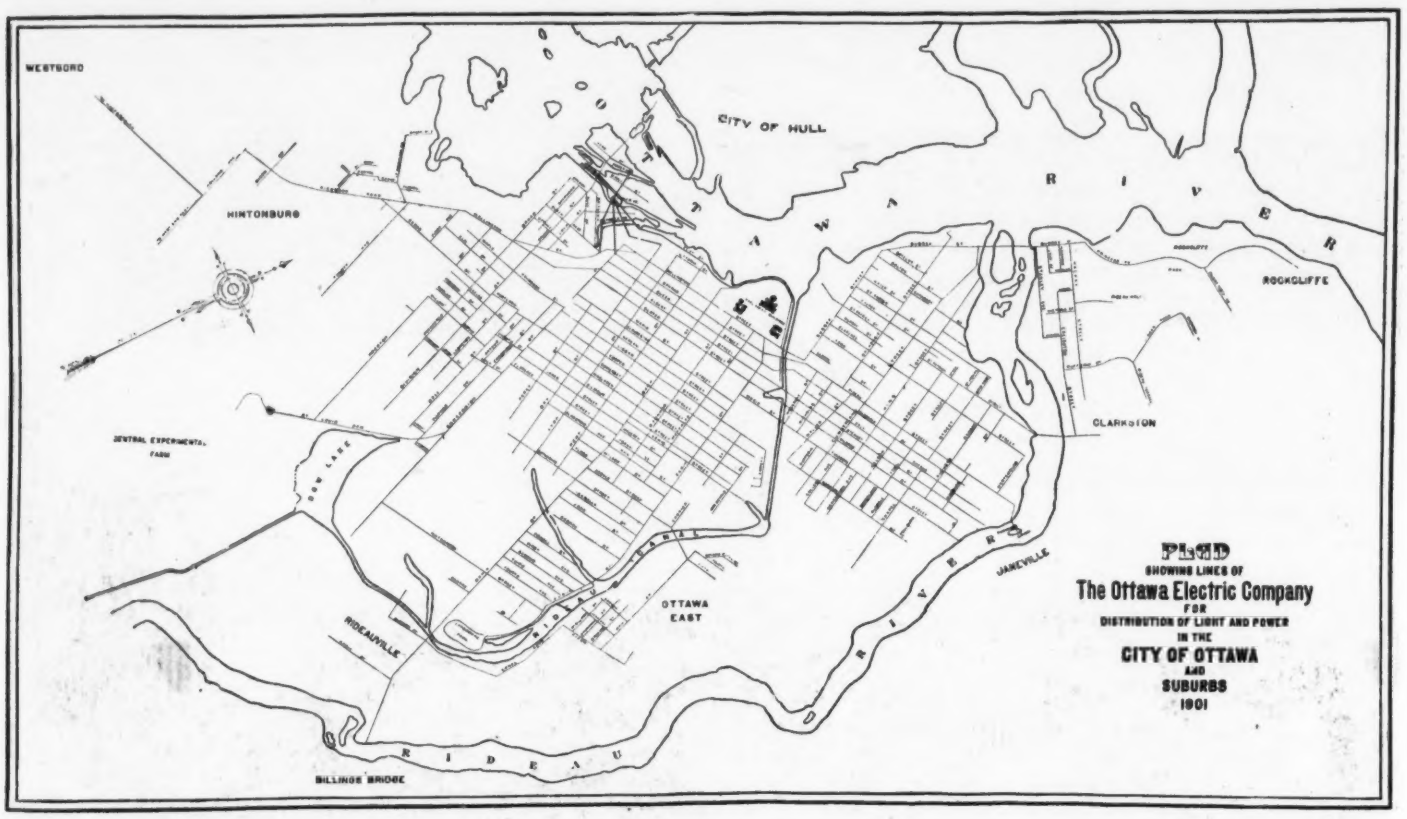


FIG. 3.—MAP OF OTTAWA, SHOWING DISTRIBUTION SYSTEM.

buildings remained standing, but among these were two of the power houses of the Ottawa Electric Company, the "Central" and the "Steam" stations; of the other four stations nothing remained but heaps of smouldering ashes, heavy stone walls having been calcined and reduced to dust. The two stations which escaped destruction had been saved in part by the efforts of the officers and employees of the company, all of whom, from the president down, turned firemen for the occasion.

There followed weeks of feverish activity for the whole staff of the company. Many and wonderful were the expedients adopted to restore the service. Those who have gone through somewhat similar experiences will appreciate the situation. Part of the incandescent and motor services was not interrupted, but inside of three weeks the whole was in operation, and more than half of the arc street lighting was resumed. Within the same time a general plan of permanent reconstruction had been adopted by the company. The "Central" and "Steam" stations were to be remodeled and improved, and both used as auxiliary stations, and one new and modern, absolutely fireproof station was to be erected to replace the four destroyed by fire, this to be the main and distributing station.

Work was begun on May 10, 1900, in clearing the debris of the fire. The extensive excavations required had to be made into solid rock, and the work was necessarily very slow. On October 24, 1901, water was turned on, and the new station started in operation. The following is a description of the several stations as they now are after this period of reconstruction:

STEAM AUXILIARY STATION.

This is situated alongside a waterway where an unlimited supply of water may be had for condensation. It is built of red brick on stone foundations in cement, the whole resting on solid rock. The engine and dynamo foundations are of solid masonry in cement. It is a one-story building, with flat roof supported on steel trusses. The roofing is of 3-in. pine lumber covered with tar and gravel. The chimney, which rests on a foundation of solid masonry 24 ft. square, built of very large blocks on solid rock, is octagonal in shape and 120 ft. high. The external diameter is 18 ft. at the bottom and 11 ft. at the top; internal diameter, 9 ft. at the bottom and 8 ft. at the top, the walls being double several feet up from the foundation. The dimensions of the building are: Engine room, 89 ft. x 77 ft., and boiler room about 45 ft. square, with a metal-covered wooden frame coal shed annexed, 77 ft. x 33 ft.

It is expected that this station will be little used, therefore no provision has been made for automatic handling of fuel, or any elaborate arrangements for high economy. The boilers are six in number, return tubular type, 16 ft. x 5 ft. in diameter, brick encased, adapted to deliver steam at 120 lbs. pressure in a common header. They were furnished by the Goldie & McCulloch Co., of Galt, Ont. The boiler room also contains two duplex "Northey" feed pumps.

The engines are two "Wheelock" tandem-compound condensing, manufactured by the Goldie & McCulloch Co., with 42-in. driving pulleys 18 ft. in diameter x 48-in. face; speed, 85 r. p. m. The condensers are of the Northey jet type. One engine is belted directly to a Westinghouse two-phase generator of 250 kw, operating at 2,300 volts and 60 cycles. The other engine is belted to a countershaft, from which is belted a second two-phase generator similar to the first. Westinghouse four-pole exciters are used. To this countershaft is also belted a Westinghouse multipolar direct-current generator, 500 kw, 550 volts. This may be used in case of a breakdown in the direct-current power plant installed in the main station, or to assist the Ottawa Electric Railway Company, the engines being adapted to be coupled together to drive this machine. The current generated in this station is transmitted to the "Central" station. The switchboard, consisting of generator and exciter panels, is similar to the generator switchboards in the other stations, which are described elsewhere.

HYDRAULIC AUXILIARY STATION.

The water for this station, taken from one of the natural canals above mentioned, known as the "Slide Channel," is led through a

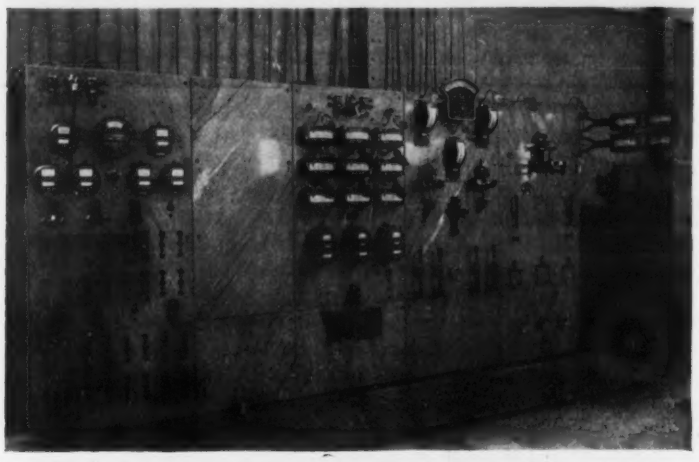


FIG. 4.—TRANSFER AND POWER SWITCHBOARD.

wide canal cut into rock to a timber bulkhead, where the level is controlled by means of stop logs; beyond this point the rock cutting extends into a pond of considerable size, along the side of which the station is built. The water enters through a wooden rack 92 ft. long by 16 ft. high, made of pine boards 1 in. thick by 6 ins. wide placed on edge 2 ins. apart. After passing through the water-wheels, which rest on heavy timber foundations and are separated by timber partitions forming box flumes, in which the wheels are submerged, the water enters short draft tubes and discharges into a rock excavated tail race, running longitudinally to and under the building, emerges through a stone arch at the lower end, and finally falls into the river a few hundred yards from the station.

The building is a substantial two-story structure, 121 ft. x 46 ft., with flat tar and gravel roof. Only about two-thirds of the ground floor is now occupied by the plant as remodeled. There is a one-story annex to this building, 109 ft. by 38 ft., facing the pond and containing the water-wheels and jack shafts. The wheel plant, which remains substantially as it was before the fire, consists of four "New American" vertical turbines, 66 ins. in diameter, made by Kennedy & Co., of Owen Sound, Ont. These are installed in four separate units, but coupled in two pairs through horizontal jackshafts, to which they are connected by crown wheel and pinion gearing. Each shaft carries a driving pulley 10 ft. in diameter. These are belted to two 700-kw Westinghouse alternating-current generators running at 327 r. p. m., the belts passing under adjustable idler pulleys set in the wall dividing the wheel house from the dynamo room. The generators are two-phase, have 22 poles, and operate at 2,300 volts and 60 cycles.

The two exciters, each of 37½ kw and each capable of exciting both generators, are of Westinghouse manufacture, four-pole, and are belted to the shafts of the generators. The switchboard is similar to that in the steam station. The current generated in this station is transmitted to the main station. In addition to the hand-wheels for controlling the wheel gates, friction gearing is provided for each wheel. Taking power from the jackshafts, this permits of controlling the speed of the wheels by means of hand levers grouped together in one place, facing the switchboard. No automatic water-wheel governors are used in this station.

THE NEW CENTRAL STATION.

The union of the two natural canals at one point forms a large pond, which is dammed at its lower end. This dam, constructed of heavy timbers, is composed of the intake bulkheads of various water users placed side by side, and a section in the center which is used as an overflow into a natural discharge channel below, which joins the main channel of the river some distance lower down. Starting from the southeasterly end of the dam and going towards the main body of the river, the bulkheads are placed in the following order: 1. The Ottawa Electric Railway Co., taking water directly off the pond, 2,000 hp. 2. The Ottawa Power Co., drawing water through a long timber flume, and supplying electric power to the Ottawa Car-

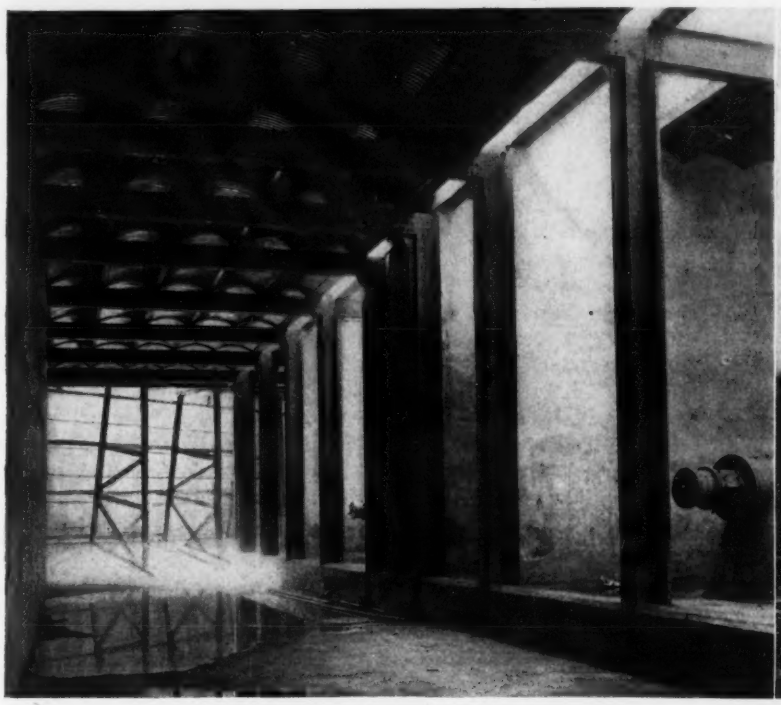


FIG. 5.—MAIN FLUME, LOOKING UP STREAM.

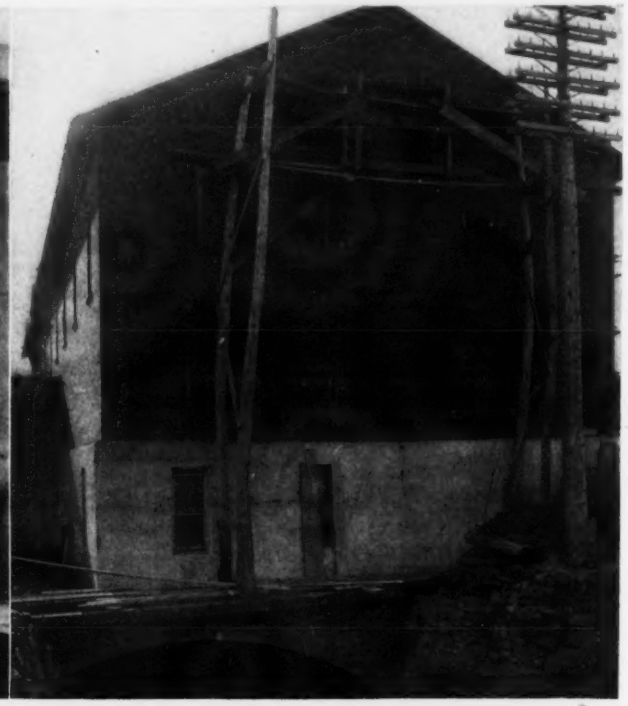


FIG. 6.—NEW CENTRAL STATION, SHOWING MAIN FLUME.

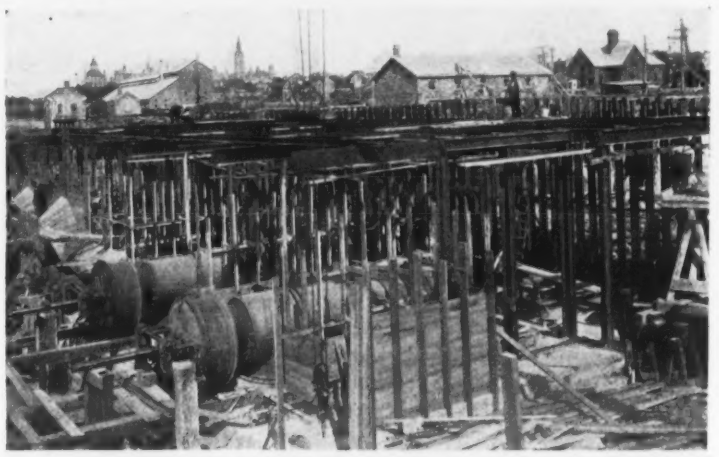


FIG. 7.—VIEW OF CENTRAL STATION DURING CONSTRUCTION.

bide Co., 4,000 hp. 3 Overflow bulkheads and discharge channel. 4. The Ottawa Electric Company new central station, 4,000 hp.

5. J. R. Booth, pulp factory under construction, to take water directly off the pond. Then comes a wide strip of rock, then Head Street, running parallel to the stream. This strip is occupied by the establishments of J. R. Booth (under construction) and the Ottawa Electric Company, both facing on Head Street.

Water for the new central station is taken past the J. R. Booth property in a massive timber flume, 32 ft. wide by 17 ft. high and

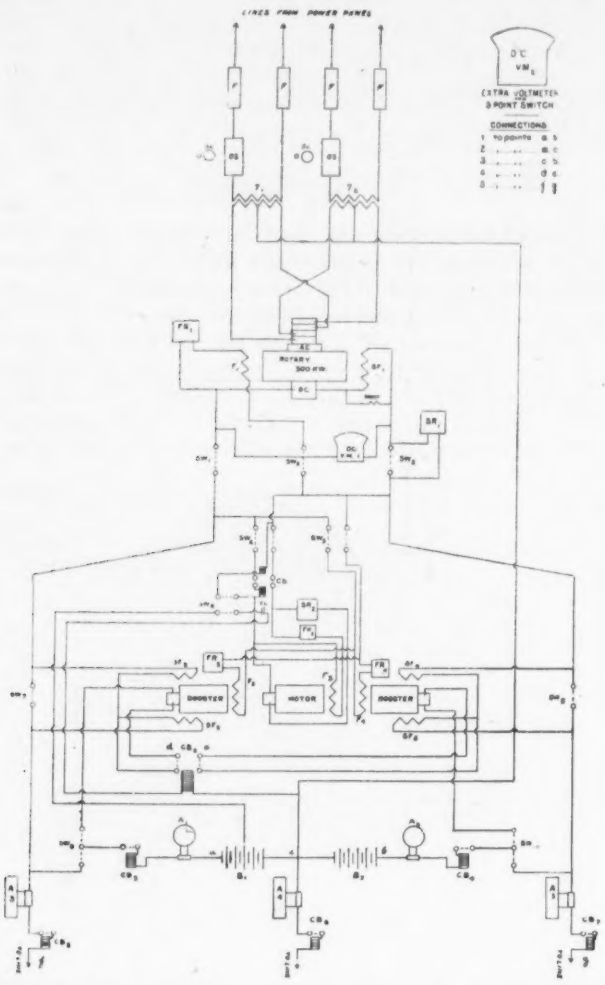


FIG. 8.—DIAGRAM OF CONNECTIONS FOR ROTARY AND BOOSTER PANEL.

FF. FF. Primary fuse blocks. OS. O S. Oil switches. SL. SL. Synchronizing lamps. FR-1. Rotary field rheostat. F-1. Rotary shunt field. SF. Rotary series field. SR.-1. Rotary starting rheostat. CB.-1. Overload no-voltage circuit breaker. CL. Buffer clips closing local circuit. SR.-2. Motor starting rheostat. FR.-2. Motor field rheostats. FR.-3. FR.-4. Booster field rheostats. F.-3. Motor field winding. SF.-2, SF.-3, SF.-4, SF.-5. Booster series field windings. CB.-2. Non-automatic circuit breaker. A.-1. A.-2. Differential ammeters. B.-1. B.-2. Storage batteries. A.-3, A.-4, A.-5. Edgewise ammeters. CB.-3, 4, 5, 6, 7. Automatic circuit breakers. SW. 1 to 10. Knife switches.

made underneath the building site 21 ft. deeper, 30 ft. wide and 150 ft. long, for the tail race. At the downstream end this connects with a similar excavation made in previous years, which, following a curved direction, joins the main channel of the river.

Three sets of horizontal turbines are installed side by side on a concrete arch which spans the tail race, and into which the draft tubes were built. This arch is 30 ft. long, has a rise of 5 ft., is 3 ft. thick in the center and 105 ft. in width. A wall 6 ft. thick and 23 ft. high separates the wheel space from the generator room, which occupies the space between the wall and the line of Head Street, the floor level being 16 ft. below the street grade. The several sets of turbines are separated by cross walls of steel framework built in 2 ft. of concrete, forming a large box flume for each wheel unit, in which the wheels are submerged. These flumes open at the rear end into a common covered flume, 20 ft. wide by 22 ft. high and 105 ft. long, parallel to the building and tail race. The outer walls of this flume are also of steel framework built into concrete 2 ft. thick, except that across the lower end, which is of solid concrete 4 ft thick at the top and 8 ft. at the bottom. In this cross wall an opening is provided—closed by an iron slide gate operated from above—and used for emptying the flume when water is shut off at the intake bulkheads. This flume is roofed over by corrugated steel arches of about 3 ft. centers, set between 6-in. I-beams and covered with concrete to a depth of 5 ins. over the centers. This forms a platform, from which access to the wheels may be had through large trap openings, and stop logs may be handled for closing any of the individual wheel flumes.

The station floor is 150 ft. long, it is 29 ft. wide for 103 ft., and for 44 ft. more 44 ft. wide, as it extends below and around the lower end of the flumes for a width of 14 ft. The upstream foundation wall of the building and the upstream opening of the covered flumes form the base of a triangular pond enclosed within concrete walls. The upper corner connects with the timber flumes already described, from which water is received. One of the sides of the triangle forms an overflow into the discharge channel mentioned above. The solid concrete wall on this side is 17 ft. high, 3 ft. thick at the top and 7 ft. at the bottom. At a distance of a few feet from the end of the station building an iron rack extends diagonally across the pond. It is 18½ ft. high and 82 ft. long, made up of flat iron bars 3 ins. by 5-16 in., placed 1½ ins. apart. The available working head of water varies from 22 to 28 ft.

The station building, which extends 15 ft. laterally over the wheel flumes, is of steel framework furnished by Jones & Laughlin, of Pittsburg, through the Stilwell-Bierce & Smith-Vaile Co., of Dayton, Ohio, 150 ft. x 45 ft. and 38 ft. high from the floor to the roof

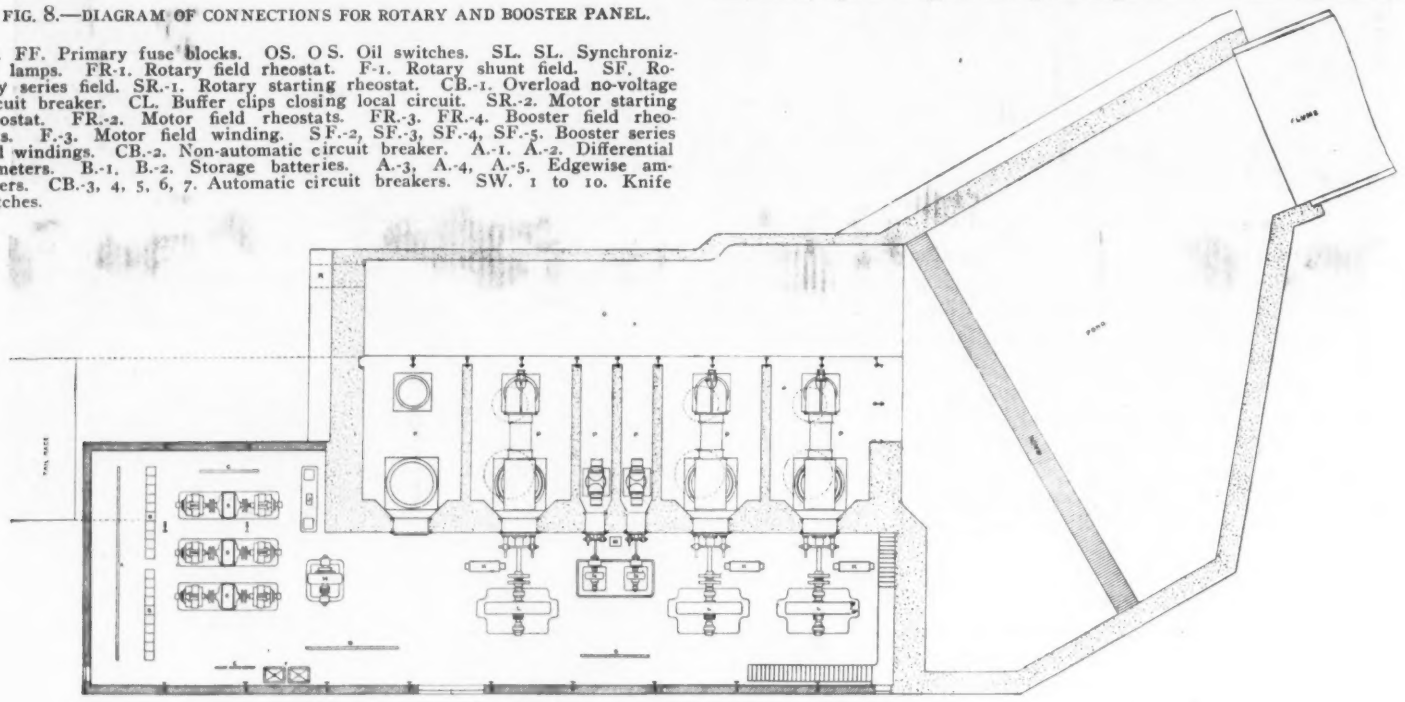


FIG. 9.—PLAN OF THE NEW CENTRAL STATION.

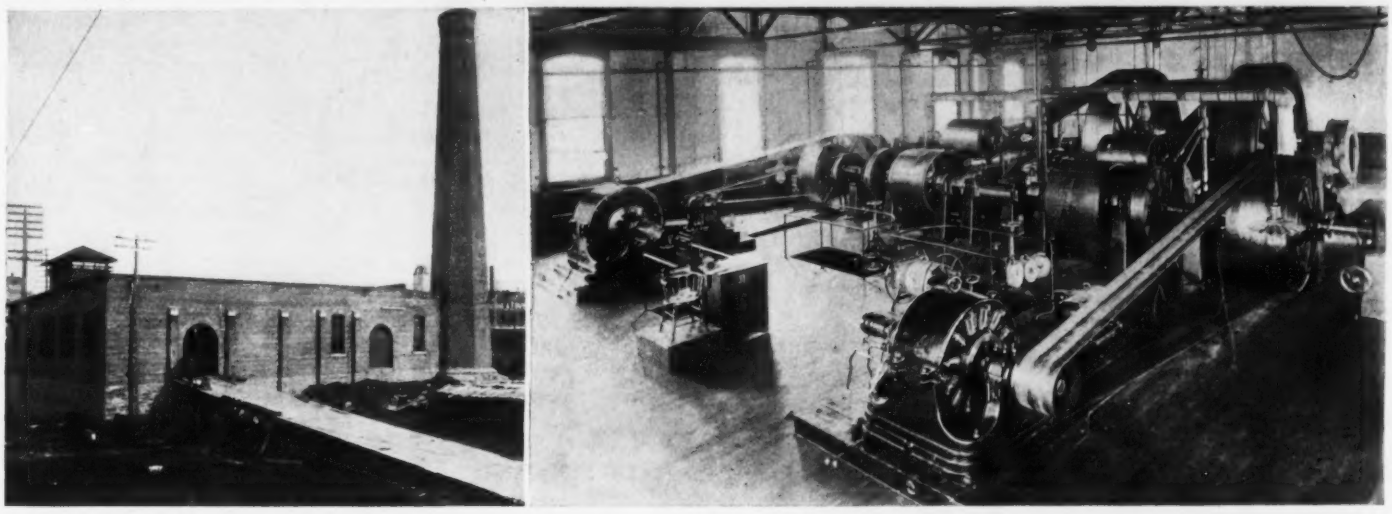
297 ft. long, built along the side of the discharge channel upon rock and concrete foundations. From this point the work of the new station properly begins. Rock having been excavated to a depth of about 16 ft. below the street level over the whole area to be covered by forebay flumes and station building, a further excavation was

trusses, with roof sloping both sides from the center at an angle of 25 degrees from the horizontal. The pillars and roof trusses are placed 15 ft. apart. Up to about 20 ft. above the floor line the walls are of concrete, and above that of red brick, 17 ins. thick, tapering to 13 ins. at the top. The roofing is a 3-in. slab of cinder concrete laid

on expanded metal, finished outside with Warren's patent gravel roofing and inside with asbestic plaster. The doors are made of channel iron framework, covered on both sides with ⅛-in. sheet iron, and set in heavy iron frames built in the brick walls. The windows, sashes and frames, are of hollow-stamped galvanized iron, with wired glass, and were furnished by the Van Noorden Co., of Boston. All stairs and railings are of iron, and were made by the Victoria Foundry Co., of Ottawa, who also furnished the iron doors. A hand-operated traveling crane of 20-ton capacity, manufactured by the Whiting Foundry & Equipment Co., of Chicago, travels on side rails placed 31 ft. above the floor. With the exception of the roof, all work of excavation building and installation was done by day labor, under the superintendence of the company's regular employees.

The extension of the upper part of the building over the wheel flumes forms a gallery 14 ft. wide and 105 ft. long, 23 ft. above the station floor. This is utilized as a storage battery room, 70 ft. by 11½ ft., and oil room and an office for the station superintendent. Troughs are provided in the concrete floor for all cables between machines and switchboards. They vary in width from 7 ins. to 20 ins. by 6 ins. deep, and are covered by cast-iron plates ⅜ in. thick by 2 ft. long. A complete system of drainage has been carried out to prevent flooding of floors and conduits through leakage during spring freshets, from the rising of water in the tail race, a contingency to be feared during years of exceptional flood. Provision is made for collecting the water into a water-tight well, from which it may be pumped. No heating is necessary in the building, owing to its situation partly below the ground level. It is lighted by six alternating-current arc lamps suspended from iron brackets 10 ft. long at a height of 19 ft. from the ground.

The turbine sets consist each of three 39-in. "Victor" wheels mounted in wrought-iron riveted casings set upon and bolted to the draft tubes, and adapted to discharge two into a central draft tube 8 ft. in diameter at the top by 13½ ft. long, and the third wheel through a quarter turn into a draft tube of 5 ft. diameter. There are three such sets, each directly coupled to and driving a generator at 180 r. p. m. Provision has been made for installing a fourth set later on, draft tubes being built in and place made ready to receive it. There are also two smaller sets coupled to exciters. These consist each of two 15-in. wheels discharging into a central draft tube 3 ft. in diameter.



FIGS. 10 AND 11.—EXTERIOR AND INTERIOR VIEWS OF STEAM STATION.

Where the wheel shafts pass through the 6-in. concrete wall, it tapers, funnel-shaped, from the wheel side to a thickness of 2½ ft. over a space just large enough to receive iron thimbles, which are built into the wall, the openings being closed by bolted cast-iron plates, through which pass the wheel shafts and the rods operating the wheel gates. The gates are of the cylinder type, worked by rack bar and pinion gearing from the generator room. These gates allow the water in which the wheel cases are submerged to enter the cases through suitable guideways to pass out through the draft tubes, which are sealed into the wheel cases. The water-wheels and fittings were furnished by the Stilwell-Bierce & Smith-Vaile Co., and installed under their directions.

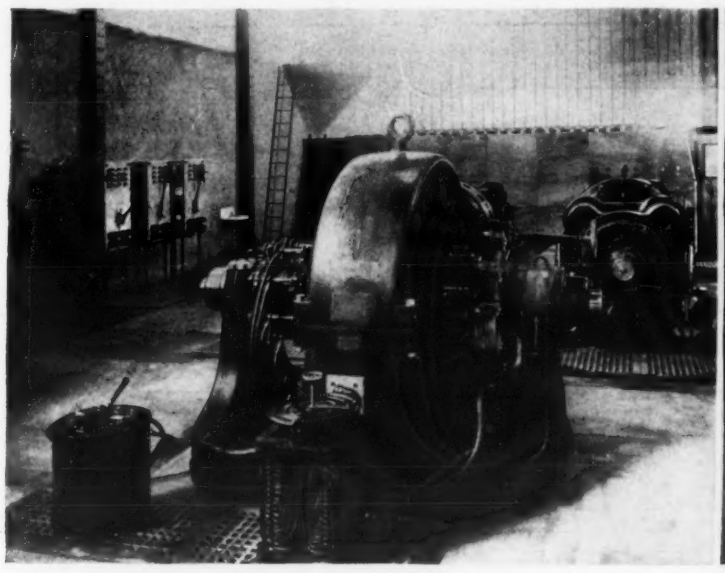


FIG. 12.—ROTARY CONVERTER.

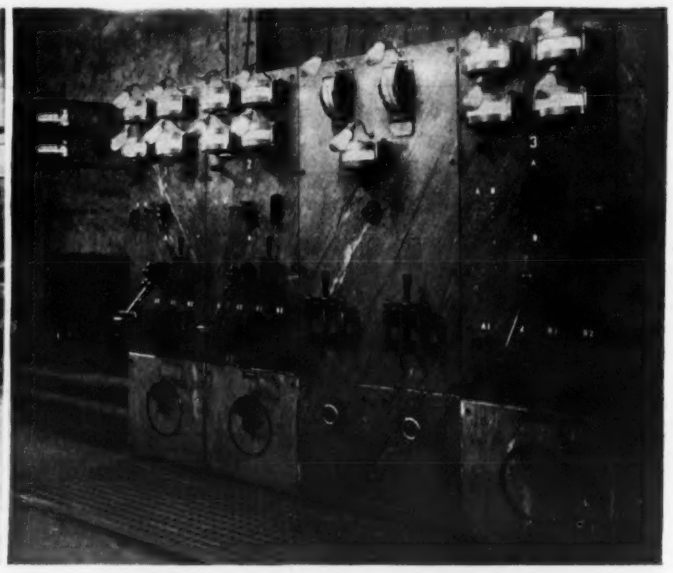


FIG. 13.—GENERATOR SWITCHBOARD.

The three large units are controlled by "Lombard" water-wheel governers set on the floor of the generator room, motion being communicated to the gate rods by small steel cables running over grooved pulleys. The small "exciter" wheel sets are both governed by one "Woodward" governor, from which either set may be disconnected at will by simply disengaging a driving pin, when the gates may be worked independently by hand. It was feared at one time that the

15-in. wheels would sometimes choke with "anchor ice," and provision was made for driving the exciters, if desired, from the neighboring main wheel shafts. No such trouble was experienced, however, during last winter.

The three generators are Westinghouse two-phase of 700 kw capacity, revolving armature type. They have forty poles, and at 180 r. p. m. give 2,300 volts at 60 cycles. The design of these machines is such as to raise the armature and the field windings above the floor line, which makes injury through flood an impossibility. The two exciters, which may be used singly or in parallel, are four-pole, compound wound Westinghouse machines of 56½ kw, mounted on a block of concrete 3¼ ft. high, in order to raise them to the level of the wheel shafts to which they are coupled. They run at 475 r. p. m. A Westinghouse 12-pole rotary converter of 300 kw provides current for direct-current motor service on a three-wire distribution 500/250 volts. Two Westinghouse oil-cooled transformers, square type, with

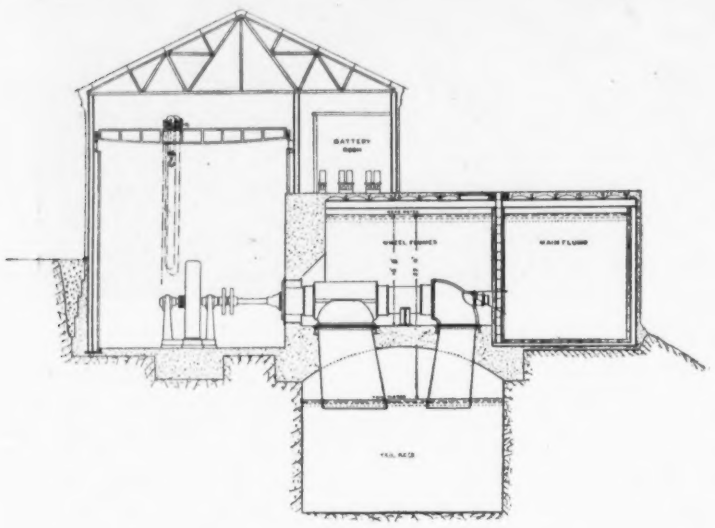


FIG. 14.—SECTION THROUGH CENTRAL STATION.

corrugated sheet iron cases, each of 165 kw capacity, furnish current for the rotary. A tap is taken from the middle point of the secondary winding of each transformer, and these taps joined together form the neutral wire of the direct-current system. A storage battery, connected across the direct-current feeders, permits of starting the rotary from the direct-current side. In case the battery should be out of service, starting current may be had from the street railway system, to which connection may be made. The rotary has been in operation on 60 cycles for many months, often at full load, first on single-phase and later on two-phase currents, with the most satisfactory results. It was necessary to provide direct current for motors already installed by customers, and for direct-connected elevators, but all other power service is being done by alternating currents on a two-phase distribution, so far entirely separate from the lighting service. The water-power available within the limits of this and the adjourning city of Hull, which is used by practically all the large manufacturing industries, restricts the field for the sale of power to the smaller users, so that this portion of the company's business has been of comparatively slow growth.

The lighting of the city streets, parks, etc., is being done under contract by the direct-current series arc system. There is a maximum of 75 enclosed 6½ amp. lamps on each circuit. Between city and commercial circuits 670 lamps are in use, all of Adams-Bagnall make. To supply these, six generators are used, each of a capacity of 150 enclosed lamps. They are Western Electric Company's two-circuit machines. They are driven in pairs by Westinghouse 250-hp two-phase induction motors, running at 580 r. p. m., a motor being placed between two generators and coupled to them. This arrangement gives the advantage of retaining the use of direct-current lamps, while making the arc lighting service independent of any one water-wheel unit, generator, or even any one station, thus insuring a constant service under almost any possible conditions, the arc generator capacity being large and the induction motors most unlikely to break down.

The storage battery equipment consists of 250 cells, "Chloride" in glass jars, with a differential booster of 11¼ kw on each side of the three-wire system, both boosters being driven by one 30-hp motor coupled thereto, all three machines being mounted on a common iron base. This battery was installed uptown at the end of the feeders at a time when the water-wheel regulation was poor and the motor service unsatisfactory, and proved invaluable in evening up the voltage under varying loads. It will now be utilized at the station, although not now so much needed, for the same purpose and for relieving the station during peak hours, if desired, to the extent of its capacity, which is not large, but may be increased 50 per cent. without changing cells. It also permits of shutting down the rotary at night, if necessary or desirable. During a use of 3½ years no trouble has been experienced with the battery. The plates are in good condition, and the only attention received has been that of one man half a day per week, but this man is required to do his work systematically, and nothing but chemically pure sulphuric acid is used in the solution.

SWITCHBOARDS AND CONNECTIONS.

The generator switchboard stands 6 ft. from the wall opposite the exciters, about the center of the station. It consists of three generator and one exciter panels, manufactured by the Wagner Electric Manufacturing Co., of St. Louis. The panels are of blue Vermont marble 2 ins. thick and 28 ins. wide, set in angle-iron frames. The generator panels have mounted on them an ammeter on each phase, a Wagner wattmeter with 3-pole, double-throw switch to connect it to either phase, a Wagner direct-current field ammeter, a voltmeter plug switch, a synchronizing plug switch and synchronizing lamps, also a Wagner 4-pole, single-throw oil switch, four S. K. C. lignum vitæ fuse blocks, a field switch with discharge resistance attachment, and the field rheostat, which is mounted on the back.

On a swinging bracket at the end are two Wagner voltmeters, one of which is connected to the bus-bars, while the other may be connected to either phase of any generator by means of the voltmeter plug switches. The synchronizing switches are used to connect any generator to a Lincoln synchronizer, which is set up on the end wall of the station and may be seen by both the switchboard attendant and the man at the water-wheel regulator, who may vary the speed as required. This instrument at the station has been found to be a great improvement on the synchronizing lamps. It makes the action of throwing generators in parallel exceedingly simple and safe. On the exciter panel, 38 ins. wide, are mounted two Weston edgewise ammeters, one Wagner direct-current voltmeter and switch, two 3-pole, single-throw knife switches, also an equalizer bar, and all neces-

FIG. 15.—VIEW OF GENERATOR ROOM, LOOKING DOWN STREAM.

sary fuses on the back of the panel, together with the two field rheostats, the operating handles coming through the front.

The connections between the generators and this switchboard, as all other connections between machines and switchboards, are made through rubber-insulated, lead-covered cable laid in troughs in the floor, covered by short cast-iron plates, which may be lifted easily. All parts of the cable system may thus be got at without trouble. From each one of the generator panels four cables are run over to another switchboard, which may be called the "transfer and power switchboard," the two left-hand panels being used to connect any of the generators, whether in this or the other stations, to either the

lighting or power bus-bars, and the two right-hand panels are devoted to the distribution of power, both alternating and direct current. Between them there is a blank panel, which was put there to allow more space for wiring at the back. This switchboard, also of Wagner manufacture, is similar as to marble and mounting to the one just described.

The transfer of generators from lighting to power bus-bars and vice versa is accomplished by means of one single-throw Wagner oil switch and four S. K. C. lignum vitæ fuse blocks for each generator. The fuse blocks are specially adapted to change the connections by being turned around; this is done, of course, with the switch open. On the transfer panels are also placed a Wagner static ground detector and switch, and eight Westinghouse integrating wattmeters, whereby the output of each station, and that proportion chargeable to the incandescent lighting system, may be measured. There is also an Elden automatic circuit breaker, through which the generators in the hydraulic auxiliary station may be paralleled with those in the main station. Owing to the absence of automatic water-wheel governors in the auxiliary station, there will be, under certain conditions, a liability to get out of step. Should this occur, the circuit breaker will immediately separate the two sets of bus-bars to which the generators are connected. Two Wagner oil switches of 750-amp. capacity and two ammeters connect to heavy cables, which lead out of the building and onto the power house of the Ottawa Power Co., whereby mutual assistance may be rendered temporarily in case of accident to any machinery.

All cables leading out of the building are heavily insulated with rubber, and run on wooden strips attached to the brick walls or the ironwork of the roof, being fastened on porcelain insulators, which for the heavier cables are iron-bound, the whole presenting a very neat appearance. Each cable is isolated and in full view. All cables were furnished by the New York Insulated Wire Co.

Behind the transfer panels are bus-bars representing the different stations, and from each set two sets of cables are attached and lead,

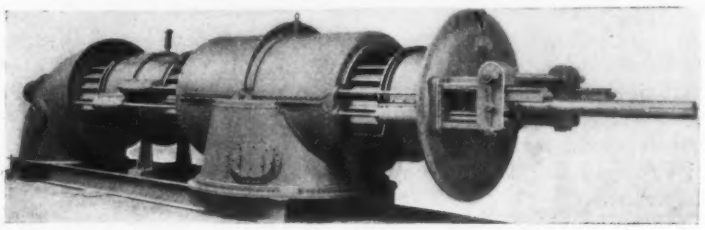


FIG. 16.—39-INCH TURBINE UNIT.

one set to the power panel adjoining, and the other to a corresponding set of bus-bars in the lighting switchboard, which is described below. In the power panel three four-wire circuits start from the main cables just mentioned. One leads to the rotary through four S. K. C. fuse blocks and an oil switch; one leads to the starting panels of the induction motors driving the arc generators, and the other goes out to the line for alternating-current power service, passing through an Elden automatic oil circuit breaker, which is also used as a switch. Each of the three circuits is also represented on this panel by two Wagner ammeters, one Wagner wattmeter on one phase, and a Westinghouse two-phase integrating wattmeter.

The two adjoining panels are used for the control and operation of the direct-current distribution, including the storage battery and boosters, and contain a number of Wagner knife switches, two Weston direct-current illuminated voltmeters, three Weston edgewise ammeters, five Westinghouse single-pole automatic air circuit breakers, one of each on each leg of the three-wire feeders and one on each end of the storage battery shunt, two Weston round-pattern differential ammeters, reading right and left from zero, one on each half of the storage battery, and two voltmeter switches. Provision is also made to cut off the storage battery and boosters in the event of current failing for any reason to the motor driving the boosters, which would cause the boosters to race. An overload no-voltage, double-pole Cutter circuit breaker is placed in the armature circuit of the motor, the shunt coil of this instrument being connected one end above the motor switch and fused cut-out and the other end below, as clearly shown on the plan of wiring. This circuit breaker, on opening, closes through the buffer clips a local circuit in which are included six of the storage battery cells, and the solenoid of another double-pole overload Cutter circuit breaker, which is thus made to open, cutting off battery and boosters.

Across the lower end of the building is situated the switchboard for incandescent lighting. It is composed of ten blue Vermont marble panels, 44 ins. wide x 1½ ins. thick and 90 ins. high (as are all the switchboard panels in the station), mounted in a frame of 2-in. angle iron braced from the wall, 5 ft. back. Each panel accommodates two pairs of feeders. These panels were furnished by the Canadian General Electric Co., and all material to be mounted thereon is now being transferred from the old distributing switchboard in the old "central," now the auxiliary station, except the indicating instruments, which were ordered from the Wagner Electric Manufacturing Co. The equipment of each feeder consists of voltmeter and ammeter, transformer and Westinghouse compensator, Westinghouse lignum vitæ fuse blocks, and an S. K. C. double-throw, double-pole slide switch, which is mounted on the back of the board, with rack bar and handle in front. Two flexible cables, terminating in wooden-handled plugs, are attached to each end of the switch, and come through to the front of the board. The plugs are adapted to enter spring receptacles corresponding to the six pairs of flat copper bus-bars at the back of the board. There are thus two pairs of buses for each station—one for each phase—to any of which any feeder may be connected.

At a distance of 5 ft. in front of the board there stands a row of static boosters in two sections, one for each feeder. They are set into a trench in the floor 1 ft. deep. The faceplates are set horizontally above the transformers, and enclosed in glass, the handles coming through. These boosters are provided with a reversing switch, and have a range of 10 per cent. up and down.

The voltmeters are zero instruments, and a change of half a volt in the secondary voltage of 110 volts causes the pointer to deflect one-half volt. With these instruments, in connection with the boosters and compensators on each pair of feeders, it is possible to maintain very close regulation at the centers of distribution.

The arc switchboard was furnished by the Western Electric Company, and is of its well-known type, with flexible cables and plugs, ammeters and polarity indicators for each circuit. There is also a Weston illuminated dial voltmeter reading to 6,000 volts, and adapted for connection to any circuit. There is accommodation on this board for sixteen circuits and eight two-circuit generators. There is a lightning arrester on every wire entering the station. Wurts arresters are used throughout.

The 250-hp induction motors are started by means of auto-transformers from marble panels containing a four-pole, double-throw knife switch, Westinghouse plunger switch and four Westinghouse lignum vitæ fuse blocks.

The storage battery cells are set on wooden trays painted with P. & B. compound and filled with sand. These are supported on porcelain legs and rest on 6 in. x 6 in. wooden stringers elevated from the concrete floor by 6 in. x 6 in. wooden cross pieces 4½ ft. apart, all painted with P. & B. compound. A large lead-lined tank contains reserve solution, which may be siphoned and led to any cell through rubber hose.

A small air compressor driven by a belt from one of the wheel shafts and a reserve air tank connected to a pipe running through the station, with tap valves at several points, furnishes means of cleaning the machinery.

The interconnection of the several stations of this company and those of the Ottawa Electric Railway Co. and the Ottawa Power Co., for mutual assistance in emergencies, is probably a novel feature in plants of this kind, but one which must be of great advantage to all parties concerned, including the company's patrons, who are thus given a degree of security not otherwise obtainable.

All the distribution is overhead, the lines covering the cities of Ottawa and Hull thoroughly, nearly 6,000 cedar poles being in use. The present installation is 99,000 incandescent lamps, 670 direct-current arc lamps, 175 motors, or 600 horse-power, besides fan motors, heaters, etc. The work of reconstruction was designed by the company's own engineers, in consultation with the Westinghouse and the Stilwell-Bierce & Smith-Vaile Companies. The executive staff of the company is composed of Messrs. T. Ahearn, president; F. P. Bronson, vice-president; A. A. Dion, general superintendent; D. R. Street, secretary-treasurer; J. Murphy, superintendent of stations; W. H. Baldwin, superintendent of hydraulic works; W. G. Bradley, superintendent of lines.

The Possibilities for a Light Weight Storage Battery.

By A. L. Marsh.

IT has become a problem of great importance to the electric automobile industry to produce a storage battery of lighter weight and greater durability than the types now in general use. It is the purpose of this article to point out some theoretical considerations which may throw a little light on this problem.

The ampere-hour capacity which a given material may possess depends upon the equivalent weights of the elements involved in the reactions of charge and discharge, and not upon their specific gravities, as is sometimes stated. For example, the equivalent weight of iron (ferrous) is 28, iron (ferric) is 18.66, lead is 103.46 and gold is 65.73, while the specific gravities are: wrought iron, 7.79; lead, 11.445, and gold, 19.258. Gold has a higher sp. gr. than lead, but a lower equivalent weight, and the equivalent weight of iron varies according to its state of oxidation. To put it in another way, the capacity in coulombs of a substance depends upon the equivalent weight of the compound as determined by its change of valency during the charge or discharge. Lead peroxide is quadrivalent, lead sulphate is bivalent and metallic lead has no satisfied valencies.

(The expressions positive active material, positive plate and positive electrode, apply to the anode in the charge of a cell. A confusion in the use of the terms *positive* and *negative* makes this explanation necessary.)

In the discharge of a positive plate in a lead storage cell, the lead changes from the quadrivalent state to the bivalent, a change of two valencies. A cell in which the lead passed from the bivalent state to metallic lead would theoretically have the same capacity for the same weight of lead; or, if the quadrivalent lead passed to the metallic state, involving a change in valency of four, the positive material would possess twice the capacity as in the first case.

The same applies to the negative material, except that the change is in the opposite direction. Metallic lead passes into lead sulphate during discharge, thus involving a change in valency of two. This change in valency is called in chemical terminology oxidation or reduction, according as the valency is increased or decreased, and whether oxygen or some other element, as chlorine, is involved in the change.

Taking up the consideration of the lead-sulphuric-lead peroxide storage cell, we find that one pound of active positive material is theoretically capable of giving 101.58 ampere-hrs. This may be calculated in the following way. Let us assume that the simple peroxide of lead (PbO_2) is the active material.

The atomic weight of lead (Pb) is.....	206.9
The atomic weight of oxygen (O) is 16, 2O =.....	32.0
The molecular weight of lead peroxide (PbO_2) is..	238.9

In the discharge of the plate, the peroxide is changed to lead sulphate, a change of valency of two. Therefore the equivalent weight of the compound is one-half of the molecular weight, or 119.45. .000010384 is the electrochemical equivalent of hydrogen in grams, or, in other words, .000010384 gram of hydrogen (equivalent weight = 1) is capable of giving one coulomb (amp.-sec.) of current. The equivalent weight of PbO_2 being 119.45, it will take 119.45 times .000010384 grams, or .0012403688 grams of PbO_2, to give give one coulomb. Since 3600 ampere-seconds = 1 ampere-hr., it will take 3600 times .0012403688, or 4.46532768 grams PbO_2, to give 1 ampere-hr. Taking 453.59 grams equal to 1 pound avoirdupois, 1 lb. of PbO_2 gives 101.58 ampere-hrs. In the negative plate we have metallic lead with an equivalent weight of 103.46. One pound of lead will give theoretically 117.27 ampere-hrs.

These calculations are for plates in the charged state. During the discharge, sulphate of lead is formed on both plates, which become heavier at the expense of the sulphuric acid of the electrolyte. Also, the figures are for the active material alone and do not allow for the weight of the grid.

In practice we do not get 101.58 ampere-hrs. per pound of active positive material. The best type of pasted plate cell on the market to-day gives about 32 ampere-hrs. per pound of formed positive paste when discharged at a four-hour rate. Under the most favorable conditions (*i. e.*, slow discharge) a cell with a conservative four-hour rating of 190 ampere-hrs. gave 270 ampere-hours. This corresponds to 43.2 ampere-hrs. per lb. of formed positive paste. The extreme limit of practical capacity seems to be about 50 per cent. of the theoretical. Practically the same thing holds for the negative active material.

Now let us give our attention to some other elements and compounds which it may be possible to use in storage cells.

POSITIVE MATERIALS.

Nickel Oxides.—By a process of calculation similar to that employed for lead we find that nickel oxides give the following theoretical capacities:

I—Nickel peroxide (NiO_2) reduced to nickelous oxide (NiO) gives 267.85 ampere-hrs. per lb.

II—Nickel peroxide reduced to nickel sesquioxide (Ni_2O_3) gives 133.92 ampere-hrs. per lb.

III—Nickel sesquioxide (Ni_2O_3) reduced to NiO gives 146.88 ampere-hrs. per lb.

Mr. Edison's theory of discharge is represented in I. The writer holds the theory represented in II, and Michalowski that represented in III.

As in the case of lead peroxide, the oxides of nickel are in fact not as simple as represented, but are hydrated oxides. Nickel oxides are used in potassium hydroxide or sodium hydroxide solutions, in which they are practically insoluble. In the discharge of a nickel peroxide plate the weight decreases, since oxygen is taken from the plate and nothing is permanently taken from the electrolyte. Cobalt forms the same series of oxides as nickel, and their capacities are practically the same.

Silver Oxides.—Silver differs from the two preceding metals in that its oxides are reduced to the metallic state in the discharge. The oxides with their capacities follow:

Silver peroxide (AgO) reduced to metallic silver gives 195.7 ampere-hrs. per lb.

Silver oxide reduced to metallic silver gives 104.6 ampere-hrs, per lb.

A small Ag_2O-cadmium cell construced by the writer gave about 56 ampere-hrs. per lb. of Ag_2O used. I think this figure can be increased. Oxides of silver are used in alkaline solutions.

Copper Oxides.—Copper oxides are reduced to the metallic state during discharge. Of course, this depends on what is used as negative material, which is also true of the silver oxides. A silver peroxide-silver couple on discharge would probably result in silver oxide (Ag_2O) on both electrodes, and a copper peroxide-copper couple would result in an intermediate oxide. But such combinations would give a low electro-motive-force and would therefore be impractical.

Copper peroxide (CuO_2) reduced to metallic copper gives 507.9 ampere-hrs. per lb.

Copper peroxide reduced to cupric oxide (CuO) gives 253.95 ampere-hrs. per lb.

Cupric oxide (CuO) reduced to metallic copper gives 304.74 ampere-hrs. per lb.

Cuprous oxide (Cu_2O) reduced to metallic copper gives 169.44 ampere-hrs. per lb.

Oxides of copper are used in alkaline hydroxide solutions. They are somewhat soluble in the alkali under most conditions, but Mr. Edison finds that an extreme degree of subdivision renders cuprous oxide (Cu_2O) insoluble.

Chlorine.—Chlorine is used as depolarizer in contact with some non-corrosive conducting electrode, such as carbon.

Chlorine gives 342.27 ampere-hrs. per lb.

NEGATIVE MATERIALS.

Iron.—Iron is best used as negative material. Ferric oxide and salts are sometimes used as depolarizers, but the e.m.f. produced is rather low. The capacities of iron are:

Iron to ferric oxide (Fe_2O_3) gives 650 ampere-hrs. per lb.

Iron to ferrous oxide (FeO) gives 433.34 ampere-hrs. per lb.

Iron to ferro-ferric oxide (Fe_3O_4) gives 577.79 ampere-hrs. per lb.

Cadmium.—Cadmium is used only as negative material. Its oxide is insoluble in alkaline hydroxide solutions.

Cadmium oxidized to Cadmium oxide (CdO) gives 216.67 ampere-hrs. per lb.

Zinc.—Zinc is used only as negative material. It is soluble in nearly all electrolytes.

Zinc to zinc oxide (ZnO) and zinc to zinc chloride ($ZnCl_2$) each give 373.3 ampere-hrs. per lb.

Copper.—Copper is used by Jungner in his copper-silver cell, as negative material.

Copper oxidized to cupric oxide (CuO) gives 381.53 ampere-hrs. per lb.

Copper oxidized to cuprous oxide (Cu_2O) gives 190.76 ampere-hrs. per lb.

The subjoined table gives in compact form the above figures on theoretical capacities:

Positive. Materials.	*Amp.-hrs. per lb.*	*Negative Materials.*	*Amp.-hrs. per lb.*
PbO_2 to $PbSO_4$	101.58	Pb to $PbSO_4$	117.27
NiO_2 to NiO	267.85	Fe to Fe_2O_3	650.0
NiO_2 to Ni_2O_3	133.92	Fe to FeO	433.34
Ni_2O_3 to NiO	146.88	Fe to Fe_3O_4	577.79
AgO to Ag	195.70	Cd to CdO	216.67
Ag_2O to Ag	104.6	Zn to ZnO	373.3
CuO_2 to Cu	507.9	Zn to $ZnCl_2$	373.3
CuO_2 to CuO	253.95	Cu to CuO	381.53
CuO to Cu	304.74	Cu to Cu_2O	190.76
Cu_2O to Cu	169.44		
Chlorine	342.27		

DISCUSSION.

Of the positive materials considered, lead peroxide stands the lowest in ampere-hour capacity per unit of weight, and the figure would be considerable lower if account were taken of the sulphuric acid withdrawn from the electrolyte during discharge.

The other materials in the positive list, with the exception of chlorine, are used in alkaline solution. In the charge, oxygen is transferred from negative to positive; in the discharge, from positive to negative. The electrolyte is unchanged as a whole and may therefore be present in just sufficient quantity to serve as conductor and to allow for the decomposition of water in overcharging.

Copper peroxide (CuO_2) gives by far the greatest capacity—five times that of lead peroxide. This compound has not been used for storage purposes, and perhaps it cannot be so used. When moist this compound decomposes at ordinary temperatures. To keep it, the peroxide must be dry, or if moist the temperature must not be much above the freezing point.

In the consideration of the lightweight accumulator it is the watt-hour capacity, and not merely the ampere-hr. capacity, which counts. Therefore the electromotive force must be taken into account in each case.

The electromotive force of positive active material may be referred to a zero standard; that is, a substance which neither adds to nor subtracts from the electromotive force produced by the action of the electrolyte on the negative electrode. In alkaline hydroxide solution silver oxide (Ag_2O) may serve as the standard, since it practically fulfills the requirements of the definition. Other oxides produce plus or minus e.m.f. according to whether they are endothermic or exothermic compounds. Lead peroxide, being used only in sulphuric acid solution, its electromotive force cannot be referred to that of silver oxide as zero standard.

The following table gives the values for the electromotive force of the different negative materials in an alkaline hydroxide electrolyte:

Negative Material.	*E. M. F.*
Zinc (amalgamated)	1.37 volts.
Zinc (pure)	1.32 "
Cadmium	.95 "
Iron	.85 "
Copper	.56 "

The values for the positive materials vary somewhat with the method of preparation and conditions of use. In alkaline hydroxide solutions the values are approximately as follows:

Positive Material.	*E. M. F.*
Nickel peroxide (NiO_2)	+.4 volts.
Silver peroxide (AgO)	+.15 "
Silver oxide (Ag_2O)	0 "
Copper peroxide (CuO_2)	+(?) "
Cupric oxide (CuO) (Black oxide)	—.4 "
Cuprous oxide (Cu_2O) (Red oxide)	—.47 "

The lead cell has the advantage of a high voltage—average about 1.9.

A copper peroxide-zinc couple (with electrolyte of potassium hydroxide solution) should give a high voltage, but this has not been determined experimentally.

Black oxide of copper (CuO), having a theoretical capacity of 304.74 ampere-hrs. per lb., gives a voltage of from .8 to .9; yet with this low voltage its watt-hour capacity is greater than that of lead peroxide. This copper-zinc combination has been given considerable attention by investigators. The chief difficulty seems to lie in the deposition of the zinc.

Cuprous oxide (Cu_2O) has a low capacity and gives a low voltage, and is not considered practical.

Nickel peroxide gives a voltage of about 1.5 with an iron negative at the beginning of discharge. During the discharge the voltage gradually falls below 1, so that the average is little better than 1 volt. The ampere-hr. capacity is rather high, if Mr. Edison's theory of discharge is the correct one, namely:

$$NiO_2 + Fe = NiO + FeO.$$

The writer's theory* is represented by the equation:

$$Ni_2O_4 \text{ (or } 2NiO_2) + Fe = Ni_2O_3 + FeO.$$

The watt-hour capacity in the latter case is rather low, the advantage in weight over the lead accumulator being due, chiefly, to the iron negative and the smaller amount of electrolyte required.

The capacity of silver peroxide is quite high, and the electromotive force which it is capable of producing is only a little lower than that of nickel peroxide and does not drop rapidly until almost discharged.

A recent invention by Signor Pisca makes use of liquid chlorine as depolarizer in contact with a conducting plate of carbon. A disc of zinc is used for the negative. The e.m.f. of this cell was not given, but it should be about two volts. The inventor claims a greater capacity for this cell than that given by other types in use, and, indeed, a much greater capacity is theoretically possible. This type of cell would have to carry enough electrolyte to hold the zinc in solution, and would be subject to the same difficulty as all zinc accumulators in the matter of redepositing the zinc in a compact and coherent mass. Moreover, chloride of zinc solution is a poor conductor of electricity compared with sulphuric acid or alkaline hydroxide solutions, and the high internal resistance would involve a loss.

Of the negative materials listed, iron has the greatest ampere-hr. capacity, and at the same time gives a sufficiently high electromotive force. It is not probable that under ordinary conditions of discharge the oxidation proceeds to the formation of the ferric oxide, though this would be possible with an excess of a powerful oxidizing agent for the positive electrode. In any case the capacity of iron is high and matches well the high capacity of a copper peroxide positive.

Under certain conditions, soluble ferrates of sodium or potassium are formed. Under the working conditions of a cell such reactions should not be prominent and probably do not occur. The peculiar property of inertness of iron and its oxides may be overcome, and will probably not prove to be a serious obstacle to their use in storage cells.

Cadmium has a much smaller capacity than iron, and is much more expensive. Its e.m.f. is a trifle higher than that for iron.

Copper has a rather high capacity as negative material, but presents the difficulties of slight solubility in the electrolyte and low e.m.f.

In a recent cell due to Michalowski, zinc is employed as the negative in an electrolyte of sodium or potassium aluminate solution. It is claimed that zinc is insoluble in this electrolyte, and may therefore be substituted for cadmium, over which it possesses the advantage of higher e.m.f. and greater capacity per unit of weight. Zinc is a very desirable metal to use in storage cells on account of its abundance and low cost as well as its higher e.m.f. and great capacity.

Another important factor in devising a lightweight accumulator is the grid. In the best pasted-plate cells of the lead-sulphuric acid-lead type the grid is about half the weight of the formed plate, and in many of the more durable varieties the grid forms a much larger proportion of the weight. This proportional weight of the grid is necessary to give the required supporting strength to the active material. A much less weight of iron or nickel will support the same weight of active material found in the lead grid, thus making the proportion of grid to active material about 1 to 2. The percentage weight of grid may be made even lower than this. Iron

* *Electrical World and Engineer*, July 27, 1901.

and nickel also show a much greater durability than lead when subjected to electrolytic oxidation.

Lead accumulators have shown themselves to be well adapted to the requirements of central station work, but for traction purposes a cell of greater durability and lightness is demanded. In the solution of this problem more inventive energy should be applied to the study of those metals and compounds which present greater possibilities than lead.

The 50,000-volt Transmission Plant of the Missouri River Power Company.

BY W. G. MCCONNON.

MUCH interest is being manifested in engineering circles in regard to recent developments in electrical power transmission over long distances and in the attendant use of higher and higher voltages. Although several plants have been proposed for the use of voltages higher than 40,000, the distinction of being the first to place in actual commercial service a large plant employing 50,000-volts transmission belongs to the Missouri River Power Company. This installation was completed and the apparatus placed in operation about the first of March, and much credit is due to the general manager and engineer of the company, Mr. M. H. Gerry, Jr., who planned and executed the work, as well as to the Westinghouse Company, which furnished the electrical equipment. Some earlier details of the work have already appeared in these pages.

FIGS. 1 AND 2.—GENERAL VIEW OF POWER HOUSE, DAM, ETC., CANYON FERRY.

It is to be noted that since the starting of the plant there has been no mishap of any kind to the line or apparatus. This, the writer believes, is somewhat exceptional in undertakings of this magnitude and character, since it is reasonably expected that at the start minor

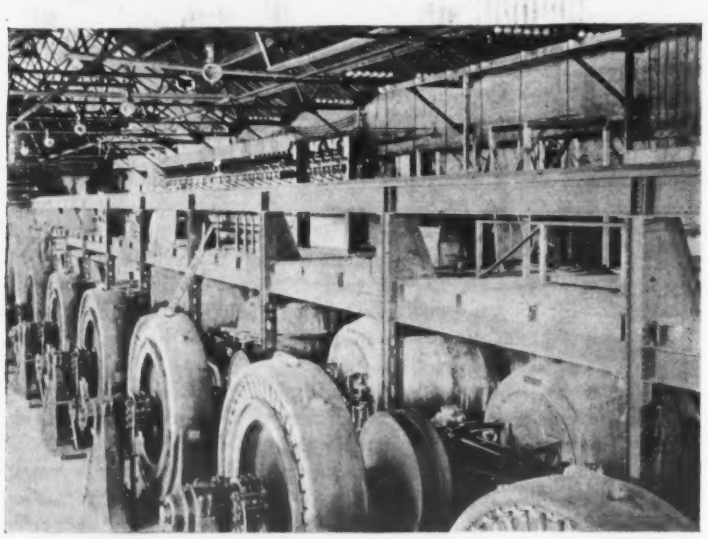


FIG. 3.—GENERAL VIEW OF INSIDE OF POWER HOUSE.

difficulties are liable to be met with, which, though possibly not serious, will nevertheless affect the continuous service of the plant.

The present power-house of the Missouri Power Company is located on the Missouri River about twenty miles almost directly east of Helena, Mont. To those who are familiar with the early history of the Northwest it will be recalled that in the famous Lewis & Clarke expedition of 1803-4 up the Missouri River and across the continent

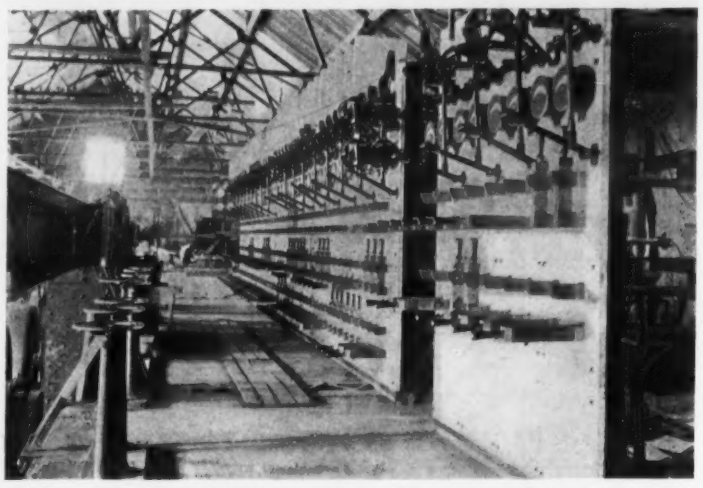
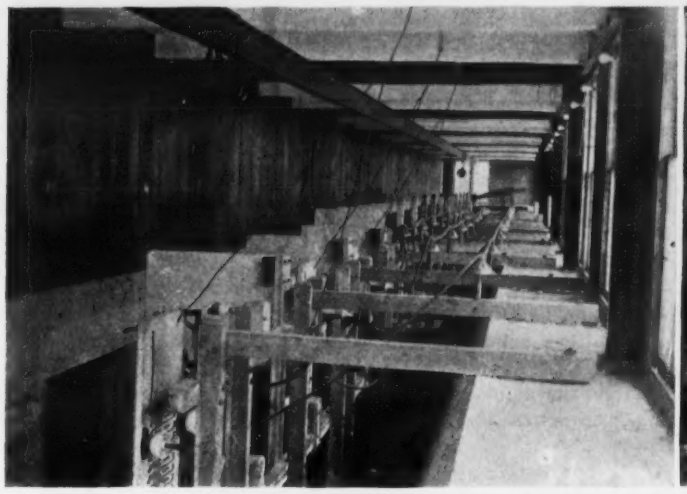


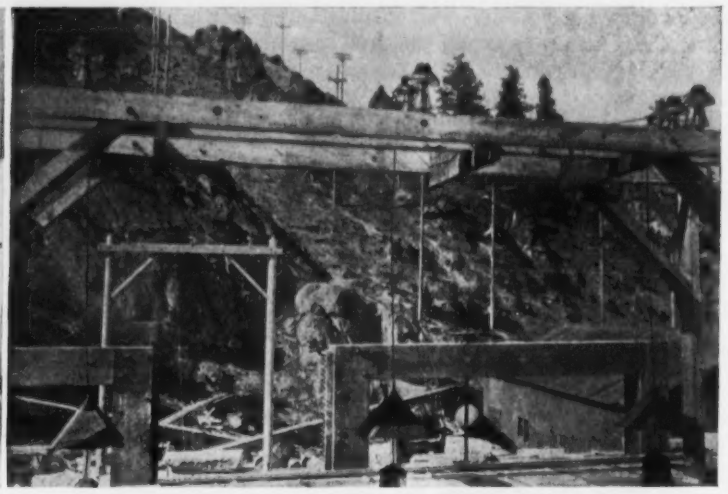
FIG. 4.—MAIN AND EXCITER SWITCHBOARDS.

to the Pacific, one of the resting places and points of interest spoken of is Black Rock Canyon, met with soon after entering the Rockies at the "Mouth of the Mountains," which is some miles to the east. Black Rock Canyon is not now known by this name, but at the mouth of the canyon lies the present little town of Canyon Ferry and the power house of the Missouri River Power Company. A general view of the power house and town is given in Figs. 1 and 2, which show them located in a country not as rough as some parts of the Rocky Mountain district, but by no means level. The district immediately about Canyon Ferry has been one of the famous gold-mining camps of the West, the discovery of gold having been made there in 1863. Placer mining is the more common way in which mining has been carried on, and it can be seen to-day to a limited extent within a mile or so of the power house.

At the mouth of the canyon a dam has been thrown across the river, about 480 ft. in length and designed to give a 30-ft. head of water. The location of the dam at Canyon Ferry had enabled the company to take advantage of a low-lying valley just above the entrance to the canyon, in which to hold at all times a large volume of water in reserve. At the upper end of the canyon the water spreads out over this valley, forming a lake about seven miles long by two to three miles wide. The canyon by which the water comes to the power house is from 400 ft. to 700 ft. wide and less than one-half mile long. The water in it does not freeze over in winter, and although the lake above freezes over, water flows to the power house as free from ice in winter as in summer. The amount of water in the river at this point is considered sufficient to develop 10,000 hp the year around.

The project for a power plant at Canyon Ferry was first started about ten years ago. The men who have taken a continuous and extended interest are Mr. Barton Sewell, of New York City, and ex-Governor Hauser, one of the pioneers of Montana, and more thoroughly identified, probably, than any other living man with her history and interests. About four years ago the decision to carry out





FIGS. 6 AND 7.—VIEW OF HIGH TENSION BUSES AND LINES LEAVING OUTSIDE OF BUILDING.

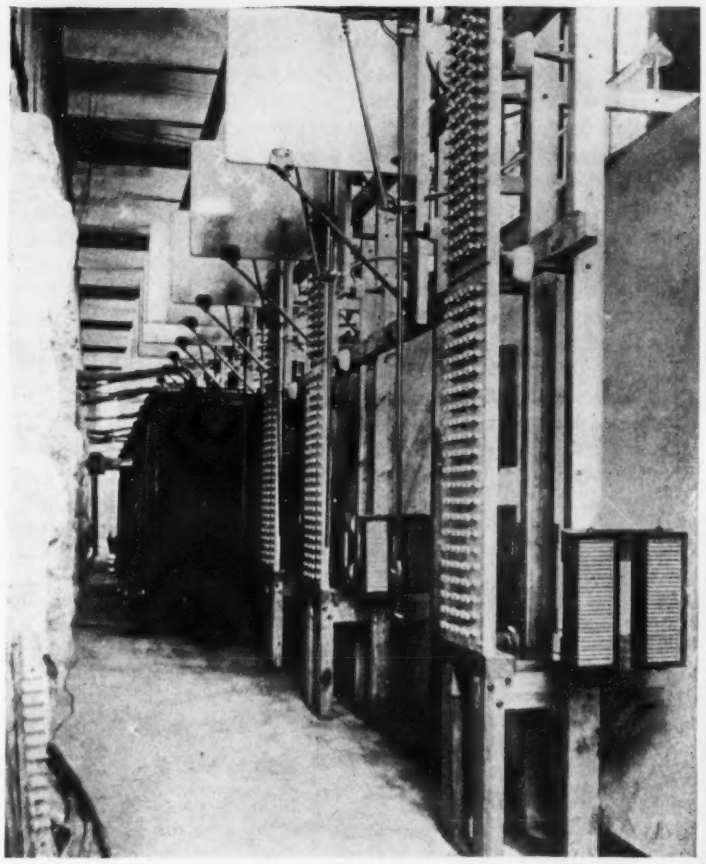
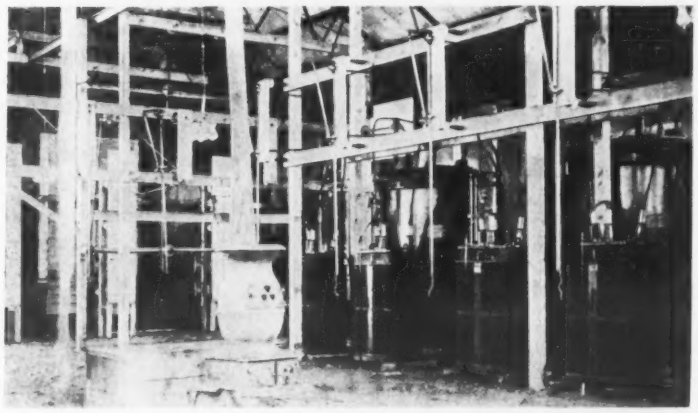
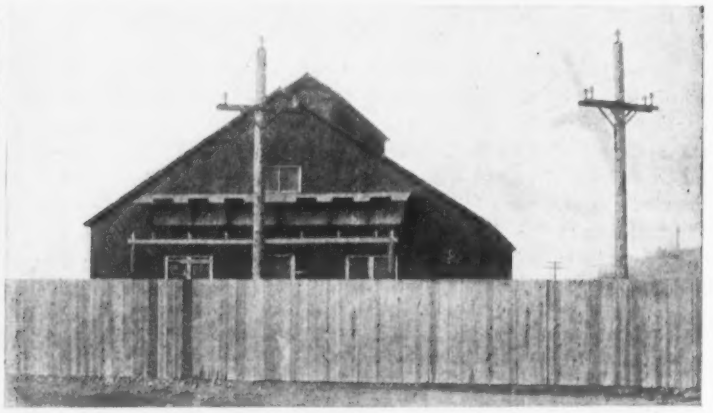


FIG. 5.—GENERAL VIEW 50,000-VOLT TRANSFORMER ROOM, FROM NORTH END

FIG. 8.—FORE-BAY, GATES, TRANSFORMER BUILDING, ETC.

FIG. 9.—HIGH-TENSION LINES OVER HILL NEAR POWER HOUSE.





FIGS. 10 AND 11.—INTERIOR AND EXTERIOR OF BUTTE SUB-STATION.

MISSOURI RIVER 50,000-VOLT TRANSMISSION PLANT.

the work at Canyon Ferry took definite shape, and work was started on a plant of 4,000 hp. This plant consisted of four 750-kw, 550-volt, two-phase Westinghouse generators, driven by Dayton Globe Iron Works water-wheels, with two 90-kw exciters driven by independent wheels. The current from these generators was raised by eight oil-cooled transformers from 550 volts to 10,000 volts, and sent to Helena and East Helena, 20 miles and 14 miles away, respectively. At Helena the current was used, after transformation to 2,200 volts, for driving induction motors direct connected to arc light machines supplying city lights, and for distribution for general incandescent lighting. Two rotary converters furnishing current to the street car system of the city were also supplied. At East Helena the current was used mostly for driving induction motors in the large smelter lo-

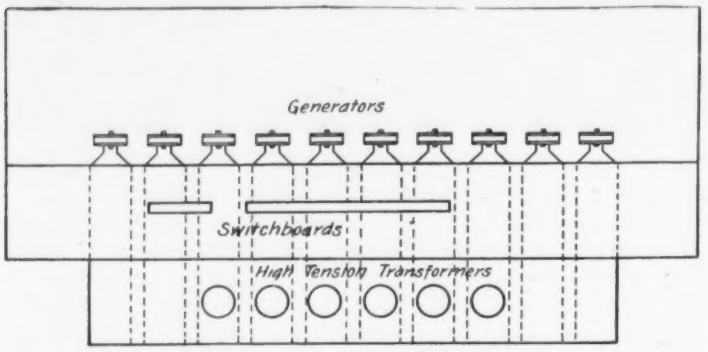


FIG. 12.—PLAN OF POWER HOUSE.

cated there and for general lighting about the works. One line from Canyon Ferry also furnished power and lights to a large ore concentrator between Helena and East Helena, known as the Peck concentrator. The line between Canyon Ferry and Helena consists of but one pole line, carrying, however, four independent circuits—one to East Helena, one to the Peck concentrator, and two to Helena, one of the latter for lighting and the other for railway work.

In the fall of 1900 work was begun at Canyon Ferry with a view of making a very considerable extension of the company's plant, the plan being to enlarge the plant to a capacity of 10,000 hp by putting in additional generators, with exciters, transformers, etc., and to extend the service to Butte, Mont., where it was expected that all the power the company might furnish could be sold. To this end the company has installed six additional 750-kw Westinghouse generators, with the necessary transformers, exciters, etc. These generators, are of the same size and voltage as the first four, but are three-phase instead of two-phase. The water-wheels are 45 ins. horizontal McCormick wheels, furnished by S. Morgan Smith, of York, Pa. All generators in the power house are direct connected to the wheels, flexible couplings being used throughout. With the new generators there was also installed a 225-kw, 150-volt exciter, driven by a separate wheel, and a 115-kw, 150-volt exciter driven by an induction motor. To sum up, the power plant now consists of ten 750-kw direct-connected generators, with four exciters, of which two are 90-kw machines direct connected to separate wheels, one a 225-kw machine with a separate wheel, and one a 115-kw, motor-driven generator. To make the plant uniform throughout, the four old generators have been overhauled and changed from two-phase to three-phase. The general plan of the station is shown by the outline sketch, Fig. 12, the switchboard gallery being on the right and directly over the water-wheels. Each water-wheel has its own governor; all the new and one of the old wheels having Lombard governors, and the remaining old wheels Replogle governors.

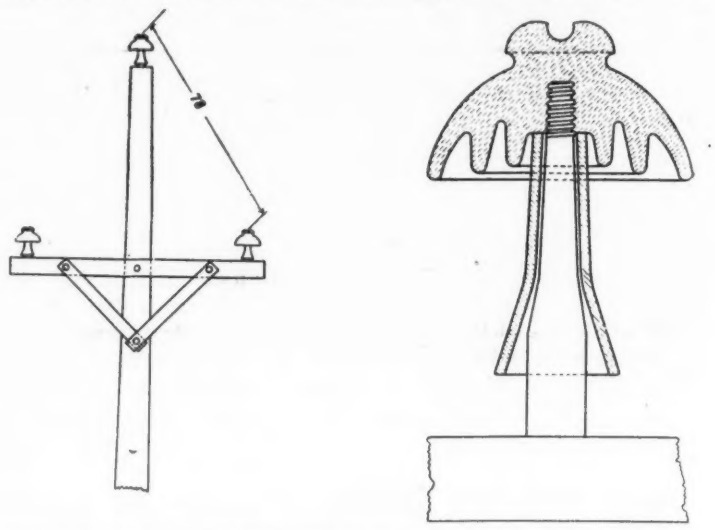
The switchboard gallery, shown on the right of Fig. 3, extends the whole length of the building, and, besides carrying the switchboards, carries also twelve 550 to 10,000-volt, oil-cooled transformers for the Helena and East Helena service, as well as a plugboard for connecting these circuits as needed under various conditions. The offices of the company will be located on the floor, extending across the building at the end from which the view is taken.

The main switchboard and exciter switchboard, shown in Fig. 4, are both relatively simple boards in design, but massive and substantial in construction. The main board is 47 ft. 5 ins. long, and consists of seventeen panels of blue Vermont marble, 2 ins. thick. The weight of the board complete is about 20 tons, the copper alone being one-half of this weight. The general arrangement is as follows: The first five panels at each end are generator panels. The next two panels are feeder panels, and are intended for use with the 550 to 10,000-volt transformers. The eighth panel from the end on each side supplies a bank of transformers, 550 to 50,000 volts, for the Butte lines. The middle panel is a junction panel, so that any set of bus-bars on the two ends of the boards can be thrown together, there being three sets of bus-bars an each end of a board. The instruments mounted on the board consist of eight 750-volt, alternating-current voltmeters, one for each set of buses and one at each end for the machines, independently of the buses; ten direct-current field ammeters; twenty-eight alternating-current ammeters, with sixteen indicating polyphase wattmeters, and six recording polyphase wattmeters. The recording wattmeters are behind the board. The exciter board consists of four panels of blue Vermont marble, similar to the main board, one for each exciter, with two sets of bus-bars. All field rheostats are mounted under the gallery floor and are controlled by hand-wheels, the shafts of which come up through pedestals in front of the boards.

The feature distinguishing the Missouri River Power Company's plant is the high voltage employed on its new lines to Butte. This is 50,000 volts. The distance by pole line from Canyon Ferry to the Butte sub-station is 65 miles, the route corresponding nearly with that taken by the Great Northern Railway between East Helena and Butte. The line starts out at an altitude of about 4,000 ft. above sea-level at Canyon Ferry and gradually rises until it reaches an altitude of 7,300 ft., where it passes over the Great Divide, a few miles east of Butte.

The line itself (Fig. 9) consists of two lines of poles about 50 ft. apart, the cables being arranged in an equilateral triangle, with a spacing of 78 ins. between centers (Fig. 13). Each line consists of three seven-strand copper cables, each cable having a cross-section of slightly over 106,000 circ. mils. These cables are transposed five times between Canyon Ferry and Butte. The average distance apart of the poles is 110 ft. Fig. 14 shows a view and cross-section of the insulator used on the line, together with the glass sleeve fitting over the pin below the insulator. It has been found, after making exhaustive tests, that a thoroughly dry oak pin of the length used in this installation boiled in paraffin will readily hold up alone under 50,000 volts. Hence the object of the glass sleeve below the insulator is to keep as great a length as possible of the pin dry under all conditions of weather.

The transformers at each end of the line consist of six 950-kw oil-insulated transformers, with water-cooling coils in the cases. Those at Canyon Ferry transform from 550 to 50,000 volts, and at Butte the step-down transformer is made from 50,000 to 2,200 volts. The



FIGS. 13 AND 14.—ARRANGEMENT OF TRANSMISSION CONDUCTORS AND INSULATOR WITH GLASS SLEEVE OVER PIN.

secondary circuits at Butte consist of 600,000 c.m. bare copper cable. All electrical apparatus in this plant was furnished by the Westinghouse Company.

The customers of the Missouri River Power Company at present number nine, as follows: At Helena and East Helena—Helena Power & Light Co., Helena & Livingston Smelting & Reduction Co., American Smelting & Refining Co., Big Indian Mining Co. At Butte—Anaconda Copper Co., Butte & Boston Copper Co., Colorado Smelting & Mining Co., Boston & Montana Copper Mining Co., Washoe Copper Co.

The general offices of the company are at Helena, Mont., and the New York office is at 71 Broadway. The officers of the Missouri River Power Company are: President, Barton Sewell; vice-president, W. S. Gurner, Jr.: secretary and treasurer, H. Suhr; general manager and chief engineer, M. H. Gerry, Jr.

European Polyphase Railways—II.

(*Concluded.*)

OTHER European polyphase railways described by Mr. Carl L. De Murault before the American Institute of Electrical Engineers, at its last regular meeting, in addition to those described in our last issue, were the following:

Burgdorf-Thun Railway.—The Burgdorf-Thun Railway, which was opened in 1899, and test data of which will be given further on, is not exactly a trunk line. Yet it is of normal gauge and forms a very important link between three of the main steam lines of Switzerland. The service conditions are the same as encountered on the other Swiss railways, and it uses the same size and shape of rolling stock as the main steam roads. The total length of the line is 40.3 km. (25 miles). The main reason for adopting electric traction was that the time-table could be arranged much more conveniently than for steam traction. With steam there would have been five trains per day in each direction, costing per year, at the least, 52,000 francs for coal alone, and each additional train would have cost 10,000 francs more for coal alone. Now, 50,000 francs allows, with electricity as motive power, the running of ten passenger and two freight trains per day in each direction over the whole length of the line, and besides three or four trains per day from Thun to Konolfingen and back. Each train consists normally of one motor car and one or two trailers, with a total seating capacity of 130-140 passengers. This means that not only is the public benefited by a better service, but the number of passengers actually carried is larger, and thus increases evidently the income of the railway by a handsome percentage.

There are sixteen stations, four of which have connection with existing steam lines.

The gauge is normal = 1.435 m.; the minimum radius in curves is 250 m.

The road starts at Burgdorf (536 m. above sea), and ascends with an average grade of 1.144 per cent. to the highest point almost exactly half-way between Burgdorf and Thun (770 m. above sea). Then it descends, with an average grade of 1.051 per cent., down to Thun (561.5 m. above sea). The maximum grade in any place is 2.5 per cent. All stations have a level stretch at least 200 m. long; 64 per cent. of the total length is straight line; 36 per cent. curves; 24 per cent. level; 23.5 per cent. on grades up to 1 per cent.; 31.5 per cent. on grades between 1 and 2 per cent., and 21 per cent. on grades between 2 and 2.5 per cent. Rails are 12 m. long and weigh 36 kg. per metre; 45 per cent. of the track is on iron sleepers weighing 137 kg. per metre track; 55 per cent. on wooden sleepers weighing 145 kg. per metre. The normal speed was fixed at 39 km. (24.2 miles) per hour.

The energy is furnished by the power station on the Kander, about 10 km. (6 miles) beyond Thun. The primary line voltage is 16,000; the number of cycles 40 per second. Fourteen transformer stations reduce this voltage in the trolley lines which was fixed at 750 volts, this being the limit set by the federal authorities at that time. This voltage, however, seems to be increased slightly in actual practice.

The number of transformers along the line was determined by the following considerations:

The distance between two transformers along the line had to be chosen so that the drop in the line voltage did not exceed a certain predetermined value. On the other hand, it was desirable to keep the number of stations within a certain limit in order to make the proportion between installed and actually working transformers as favorable as possible. It will be noticed that at any time only those transformers between which trains are actually circulating are under load, while the rest are not doing any work. Finally, the transformers should be placed as near the railway stations as is practicable, so as to facilitate their inspection. These somewhat conflicting conditions led to the adoption of fourteen transformer sub-stations, with an average interval of 3 km. from one another, the maximum interval being 3.4 km., the minimum 2.4 km. The two end transformers are 500 m. from the terminals of the line.

The size of each transformer would really be dependent on the grades in its vicinity. As these grades are pretty nearly alike in this case, the capacities of the transformers worked out to be very much the same, also, and it was therefore decided to use one size of transformers only, with a maximum output of 450 kw. This is the power required to move two complete trains.

The high-tension line first passes an emergency switch, which permits cutting off the whole station. The transformer is placed in a small iron house containing in its upper part primary and secondary fuses; there is also a lightning arrester on the top of each station. The transformers are of the oil-cooled type, and transform from 16,000 volts down to 750 volts. On the secondary side one pole is connected to earth, viz: to the rails; and the other two are carried over to the other side of the track, where they enter a special little switchboard placed in an iron box, which allows cutting off the transformer from the line, or else either of the two line sections meeting here from the transformer. The whole length of the line is thus effectively cut up into fifteen sections. The secondary box also contains a secondary lightning arrester. Most of the substations are also equipped with a small 2-kw lighting transformer, furnishing the current for lighting the neighboring railway station.

The trolley line consists of two copper wires of 8 mm. diameter, suspended by means of steel cross-wires from wooden poles placed on both sides of the track. These poles are normally about 35 m. apart; somewhat less in curves and grade crossings. The height of the trolley wires above the rails is 5.2 m. (16 ft.) at the most, and at least 4.85 m. The rails form the third conductor, and are bonded by means of a special metallic paste.

The contact devices of the cars consist of four steel frames per car, as shown on Fig. 4, two on each end of the car roof at a distance of about 9.5 m. (31 ft.) from the other two, the contact bar being a brass roller of special shape. This double set was found to

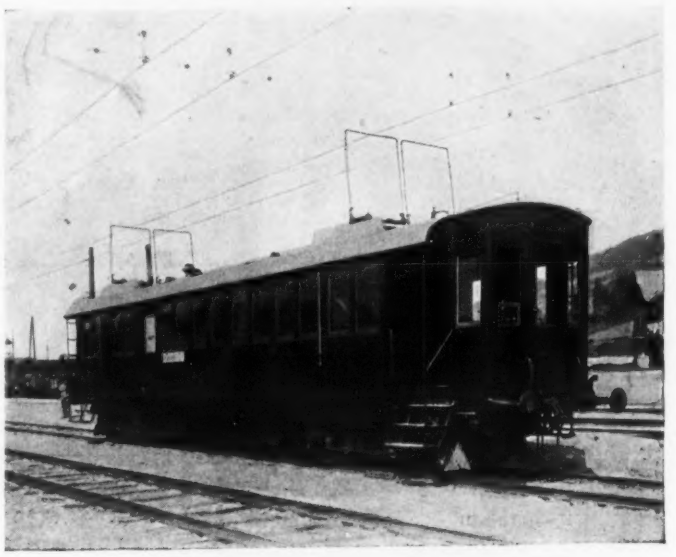


FIG. 4.—MOTOR CAR, BURGDORF-THUN RAILWAY.

be necessary in order to facilitate the passing of switches without breaking the current. At the switches the two outer trolley wires are carried right through, while the two inside ones terminate in insulated sections, prolonged into a common meeting point, and there anchored by insulated guy wires. The distance of 9.5 m. between the two sets of contact devices is just long enough to allow three of the four bars making contact under any condition. There is, therefore, no sparking at switches, and it is possible to stop a car underneath a switch and to start it again in the same or the opposite direction.

There are two kinds of motor cars, the passenger automobile and the reguar locomotive for freight trains. If this railway had been entirely independent the passenger trains would perhaps consist of one car alone. As it is, the traffic to be handled at the stations having connection with the steam roads necessitated larger carrying capacity of all the trains. The normal train composition comprises one motor car weighing 32 tons, capable of pulling a weight of about 20-24 tons in trailers on all grades and at normal speed. The motor car has seats for sixty-six passengers and the trailers for sixty to seventy more, making a total seating capacity for between 130-140 passengers.

A general view of a motor car is given on Fig. 4. It is a double bogie car, with a 64-hp, three-phase motor geared to each axle. The gear ratio is 1 : 3, and the speed of the motors 600 r. p. m., equivalent to a train speed of 39 km. (24.2 miles). The four motors are connected with their stators in parallel. The line current passes first

through one of the two controllers, placed one on each car platform, then through automatic cut-outs to the motors. The first motion of the controller handle serves to close the switch, thereby connecting the stators to the line, at the same time cutting in four rheostats, one into each rotor circuit. Subsequent turning of the controller handle works a combination bevel and chain gear, through which three carbon brushes are moved on a sort of commutator attached to each rheostat, whereby all the resistance is gradually taken out and the rotors left short-circuited. A second handle on the controller reverses the direction in which the car is going by changing two of the main leads. Each car platform is equipped with two ampere-meters, one voltmeter and a recording tachometer. A Westinghouse brake and an electric lighting and heating installation complete the equipment.

One of the freight locomotives is shown in Fig. 5. They are de-

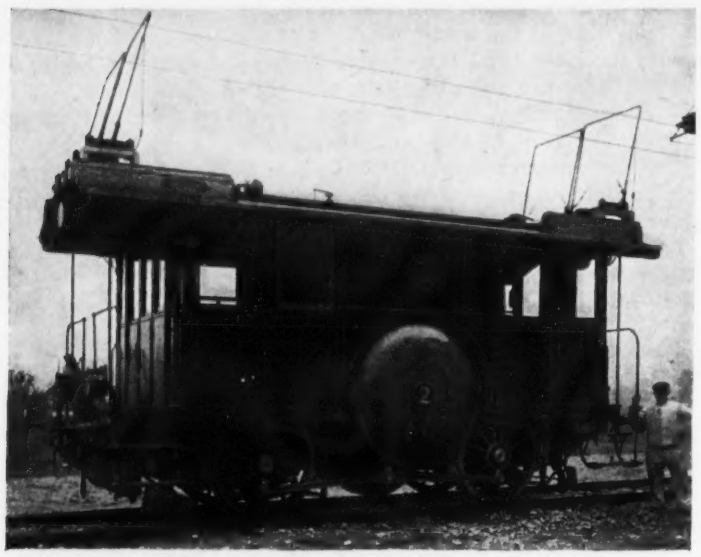


FIG. 5.—FREIGHT LOCOMOTIVE BURGDORF-THUN RAILWAY.

signed for a speed of 19½ km. (about 12 miles) per hour, and will haul a weight of 100 tons (not including their own weight) up the steepest grade of 2.5 per cent. The weight of a locomotive complete is 30 tons, equally divided between two axles. Two motors of 150 hp each are mounted on a common shaft half-way between these two axles, and drive by means of a reduction gear first an intermediary axle, and from this axle by means of connecting rods all four driving-wheels. These are 1.23 m. (almost exactly 4 ft.) in diameter. A common rheostat serves for starting both motors, and there is a controller on each platform, as in the case of the passenger cars. The same measuring instruments are also to be found, as well as a Westinghouse and an additional hand brake.

This railway has now been in successful operation for almost three years. It was equipped by Brown, Boveri & Co., of Baden, Switzerland, as well as the other Swiss lines mentioned. Later on some actual results obtained on this road will be given, but attention is directed first to three experimental lines recently installed for the purpose of ascertaining the conditions met on long trunk lines with higher voltages and very high speeds.

Lecco-Colico-Sondrio-Chiavenna Railway.—In 1901 Ganz & Co., of Budapest, finished the electric equipment of what is usually called the Valtellina Railway, in the northern part of Italy.

The length of the line from Lecco to Chiavenna is 65 km. (40 miles), the branch from Calico to Sondrio 41 km (25 miles). The gauge is normal = 1.43 m. The normal speed is 60 km. (37 miles) per hour for passenger trains and 30 km for freight trains. It is evident that under these conditions it would have been somewhat difficult to handle the traffic with 750 or even 1,000 volts, and it was therefore decided to adopt a higher voltage. Tests made in the Alt-Ofen shipyard, near Budapest, showed 3,000 volts to be very suitable for the purpose, and this is the line voltage definitely chosen for this road. The power station generates 20,000 volts at 15 cycles per second; twelve transformers of 300 kw each, along the line about 10 km. from each other, reduce this to 3,000 volts. For short periods these transformers can give three times their normal output with a 6 per cent. drop in voltage. There are two 8-mm. trolley wires, the track serving as a third conductor. The rolling stock shows passenger automobiles weighing 50 tons, and freight locomotives weighing 40 tons each. Both are of the double-bogie type, with one motor of 150 hp on each of the four driving axles. The motors are mounted direct on hollow shafts on the axles, driving the latter by means of a flexible coupling. For the passenger cars the so-called "cascade" connection is made use of, two of the motors being connected to the 3,000 volts directly, the other two to the 300 volts induced in the rotors of the first two. Thus half normal speed is obtained and a certain economy in starting. The freight locomotives, however, use resistances only for starting purposes.

Fig. 6 shows one of the passenger cars with a trailer. The contact device is of the roller type, two copper rollers, 40 cm. long, being separated by a piece of hard wood 12 cm. long, saturated with paraffin under pressure. In the interior of the cars the high tension is carried in iron pipes, insulated inside and connected to earth. The current enters the stators of the motors after passing a high-tension switch placed in a separate chamber. Thus all possible means have been employed to insure absolute safety to the passengers. Trial runs have been made on this line, but several details seem to need to be perfected, and the line is not yet open for traffic.

Tests at Grosslichterfelde.—Still higher voltages were used by Siemens & Halske in 1899 and 1900 during extensive tests made on the Teltower Road, between Grosslichterfelde and Zehlendorf, on a specially constructed test track a little over one mile long, normal gauge, with curves 200, 100 and 40 m. radius. On account of the traffic on this public road the contact line had to be placed on one side of the road, and for the same reasons a guard wire net had to be fixed under all wires. The main object of these tests was to find a suitable contact device and the best possible line construction to handle a current of 10,000 volts and at car speeds up to 60 km. (37 miles).

The first tests were made with a device making contact with the line from above. The line wire was fastened to triple petticoat porcelain insulators by means of special brass pieces. The insulators were mounted on wooden cross-arms of different lengths, which were hinged to iron poles in such a way as to permit the tension in the wires to be equalized without difficulty. The three wires formed an inclined plane.

Later the line construction was changed and arranged for making

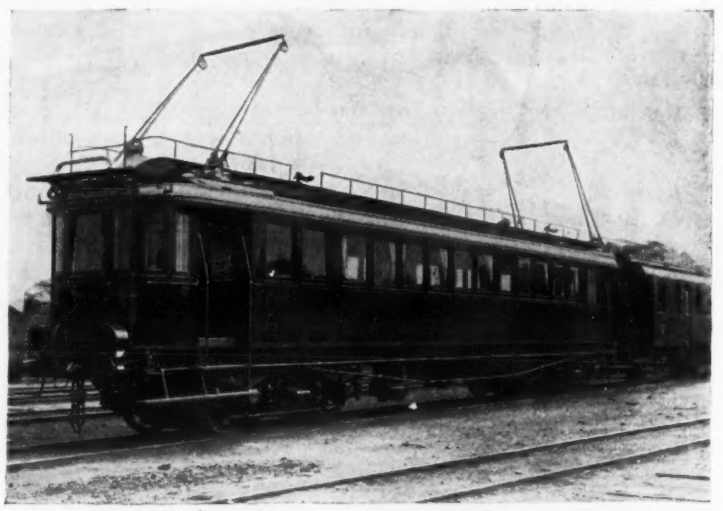


FIG. 6.—CAR AND TRAILER, LECCO-CHIAVENNA RAILWAY.

contact from the side. The three wires were placed in a vertical plane, with distances of about one yard from one another. The wooden cross-arms were replaced by elliptically curved angle irons provided with a guy wire, to which the insulators were fastened, inclined towards the track.

In both cases tests were made with line voltages of 750, 2,000 and 10,000 volts. The locomotive was fitted with two three-phase induction motors, one on each axle and each for 30 hp normal and 120 hp maximum output at 650 volts. With 850 volts the output would be increased to 200 hp per motor. These motors had interchangeable armatures, so that they could be used for 750 or 2,000 volts directly with the line voltage. For the tests with 10,000 volts on the line, a transformer was installed on the locomotive to transform down to 750 volts. There were two different reduction gears, which could be

inserted alternatingly, one for 40 km. an hour, the other for 60 km. an hour. The total weight of the locomotive completely equipped was 16 tons.

From the tests made the following results were deduced:

1. It is entirely feasible to use line voltages up to 10,000 volts, and the necessary energy could be taken from the line in each case without difficulty.

2. The contact from the side is rather the better of the two.

The Zossen Railway.—These results were availed of for the tests which are now being made on the normal gauge line from Marienfelde to Zossen, about 15 miles long, where the line voltage is 10,000 volts at 45-50 periods per second and the speeds attempted up to 220 km. (135 miles) an hour.

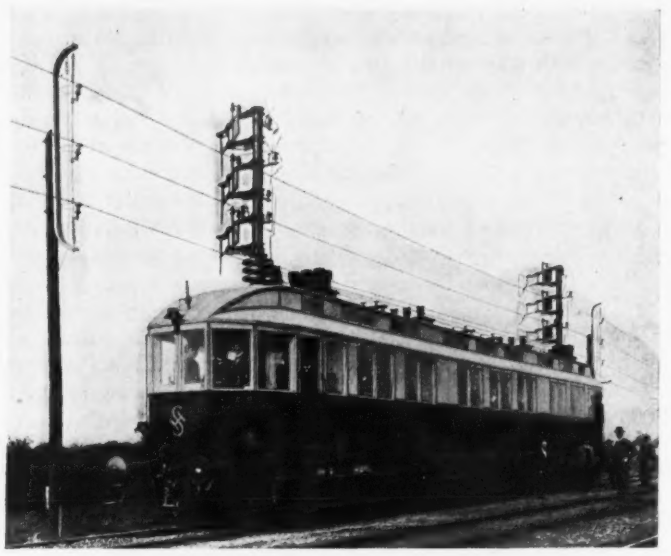


FIG. 7.—CAR ON ZOSSEN RAILWAY.

It would lead too far to go into details regarding these tests, which have not yet been completed. Suffice it to say that as far as the electric equipment is concerned, they have been entirely satisfactory. The maximum speed obtained up to now is 160 km. (100 miles) per hour.

Fig. 7 shows one of the cars employed, and it will be noticed that line and contact device are shaped after the models used during the tests carried out on the Teltow road. There are four motors per car, each of 250 hp normal and 750 hp maximum output. The car, when completely equipped, weighs 90 tons, and is designed to take fifty passengers.

Tests on the Burgdorf-Thun Railway.—Some special tests made on the Burgdorf-Thun Railway will here be described.

First, the overload capacity of the passenger cars was tried. These cars were designed to haul normally a total train weight of 50 tons on all grades at a speed of 39 km. (24 miles) an hour.

A test train was put together to weigh 70 tons total, *i. e.*, 40 per cent. overload, and the motors did their work very well indeed, starting on the 2.5 per cent. grade without any trouble whatever. If, therefore, one of the four motors of a car should ever be temporarily out of order, the other three motors will be able to deal with a normal train alone.

In actual service neither the motors nor the transformers show any appreciable rise in temperature. The transformers are, of course, under load for short periods only, say 10 minutes at a time. Their size was therefore evidently not determined by their heating, but by the maximum drop in voltage, which in this case was not quite 10 per cent.

Fig. 8 shows in curve form the results of some starting tests made under three different conditions:

a. One motor car alone, weighing 32 tons. *b.* One motor car hauling two trailers, total weight 55 tons. *c.* One motor car hauling three trailers, total weight 70 tons.

The curves show speed, amperes per phase and volts as functions of time. The tests were made on the level and the controller manipulated so as to keep the current as nearly as possible constant at 200 amps. This represents actual working conditions.

Readings were taken on the instruments mounted on the car at regular intervals of 5 seconds, the usual employee of the road acting as motorman. The automatic speed record made by the speed indicator corresponded very closely in each case with the curves thus obtained.

It will be seen that a weight of 32 tons was brought up to a speed of 24 miles an hour in about 32 seconds, a weight of 55 tons in about 57 seconds, and a weight of 70 tons in about 78 seconds.

The total energy input up to the point where full speed was reached is something like 1,600 watt-hours in the first case, 3,000 watt-hours in the second case, and 3,900 watt-hours in the third case, or approximately 52, 55 and 56 watt-hours per ton, respectively, a power factor of 0.8 being used to calculate real energy.

These results appear to compare very favorably with such as have been recently obtained with continuous-current motors, and this in regard to time in getting up speed as well as in regard to energy consumed during acceleration.

By the use of the series parallel controller continuous-current motors can be made to consume, I believe, as a minimum about 40-45 watt-hours per ton under similar conditions, which would be a little less than 80 per cent. of the energy consumed by the above alternating-current motors. There is, however, this point to be taken into con-

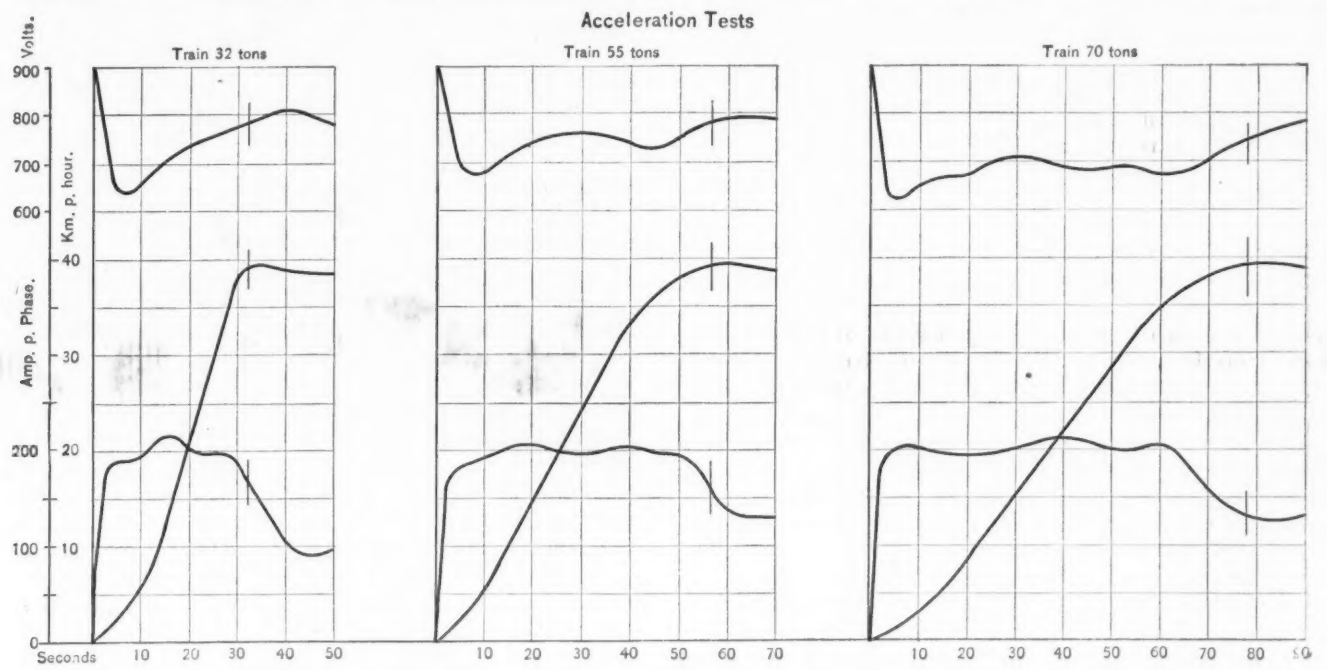


FIG. 8.—CURVES PLOTTED FROM STARTING TESTS, BURGDORF-THUN RAILWAY.

sideration, that the maximum power input in the case of alternating-current motors is not very much above the average input, while in the case of the continuous-current motor the energy curve has a very decided point, making the maximum input always more than 50 per cent, and often 100 per cent., more than the average input. The times given above for getting up full speed are rather better than has been obtained so far with continuous-current motors.

Fig. 9 represents some readings taken during a regular time-table run of a normal passenger train weighing 50 tons, from Walkringen to Konolfingen, viz: up and down over the highest point of the road.

It will be noticed that very severe grades were encountered. The curves show the normal speed up the grade to be about 38 km., on the level stretch on the top about 39 km., and on the down grade about 40 km., or a slip of about 2 per cent. both ways.

The amperes curve clearly shows the difference between energy consumed in going up and energy returned when coming down. Of course, the power factors will be different in the two cases, and the real amounts of consumed and returned energy cannot be calculated from this curve. It is, however, interesting to see how the voltage increases on the down grade, thereby clearly indicating that the load is taken off. This test was made with the brakes wide open all the time, and the motor resistances were used for starting purposes only.

A further test showed that by inserting resistance in the motors while on the down grade the speed can be increased materially, and

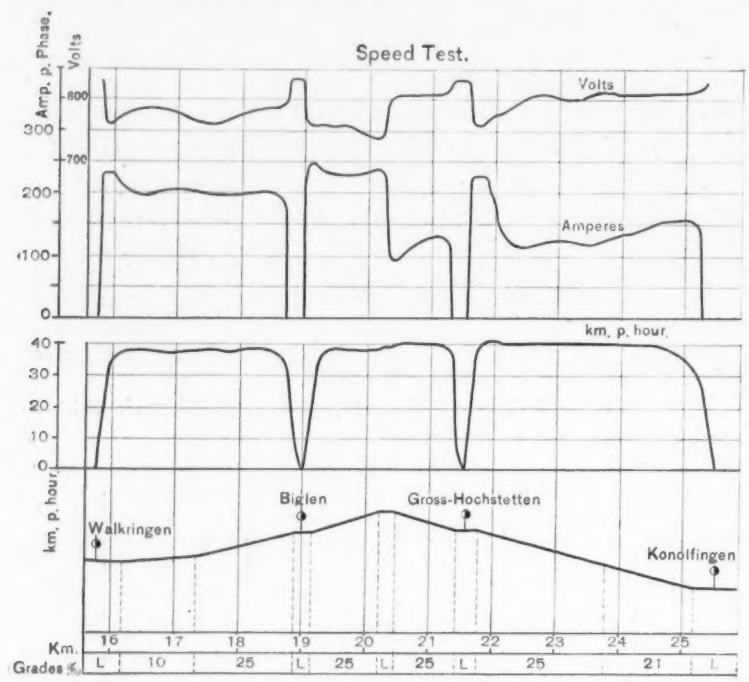


FIG. 9.—READINGS TAKEN DURING A RUN ON BURGDORF-THUN RAILWAY.

the speed reached on this occasion was about 44 km. on a down grade of about 1.4 per cent.

Finally, a test was made on a fully loaded train which was going up hill on a 2.5 per cent. grade. It was suddenly changed to going down. All brakes were left open, and yet the train settled on its downward trip at the normal speed of about 40 km., which was not exceeded. Then its direction was changed again, and the start was made without any difficulty whatever.

From these tests Mr. de Muralt drew some interesting conclusions, as follows:

1. If properly designed, alternating-current motors can be made to start under full load with not more than normal full load running current. They will also start under a considerable overload. The only condition which has to be strictly observed in the case of alternating-current motors is that the drop in the line voltage may not exceed a certain percentage, say 15 per cent., to be on the safe side. In this respect the continuous-current system is more elastic, and a cotinuous-current motor will start with full torque even under very low voltages. In practice there is, however, no reason for allowing excessive drops in the line. Besides, it would be easy to install on particularly exposed points transformers giving a somewhat higher secondary voltage in order to increase the torque of the motors in these cases.

2. In regard to acceleration, it may be said that alternating-current motors are well adapted for accelerating quickly and uniformly up to full speed. Compared with continuous-current motors, they show a somewhat shorter time to get up full speed, a somewhat increased amount of energy consumed during the acceleration and a smaller maximum energy input.

3. During the run the speed of the alternating-current motor was found to be practically constant on the level as well as on all grades, as it is dependent practically only on the number of cycles of the generators. This means that alternating-current motors must be proportioned so as to be able to draw the maximum weight at normal speed on the maximum grade. Continuous-current motors need not have the same output, as it is possible, especially in the case of several motors per car, to give the motor momentarily a greater torque by reducing the speed. This, however, is only feasible within certain limits, and actual practice has shown that the gain in weight of motor thus obtained is very small compared with the weight of an alternating-current motor running always at the same speed. In most cases it will hardly exceed 10-15 per cent. Besides, as pointed out above, the voltage of the line might be increased at the grades in order to increase the capacity of the alternating-current motor.

4. On down grades the alternating-current motor acts as a generator, returning energy to the line. This recuperation of energy is not only theoretically feasible, but is of actual interest in the case of prolonged down grades where the motors thus automatically brake themselves and where the descending trains greatly relieve the power station. In Siemens & Halske's tests the alternating-current generators were driven by continuous-current motors from a storage battery. When the car was going down grade, energy was returned and the storage battery actually charged. The Swiss mountain lines have installed water resistances to use up the excess of energy set free by descending trains.

5. In a mechanical way the alternating-current motor is, of course, superior to the continuous-current motor. The absence of the commutator alone is an advantage. Then the voltage in the rotor can be chosen as low as convenient, which makes the rheostats better and safer. All the Swiss roads, which have been operated now between 3 and 4 years—the Lugano Tramways even 7 years—report having had practically no repairs whatever on any parts of the electrical equipment, none whatever on the motors, which is more than can be said of the usual continuous-current equipment.

6. Finally, the manipulation of the cars is greatly simplified by the constancy of speed, which in this connection is a decided advantage. All the motorman has to do is to start his car and bring it up to speed. The car itself will do the rest until it is stopped by the application of the brake. The concatenated motor control, although showing a slightly bettter efficiency during starting, makes the controlling apparatus more complicated, and it is therefore preferable in most cases to adhere to the ordinary resistance control, which has really showed up to be pretty efficient after all.

7. The increased voltage admissible for alternating-current systems reduces the dimension of the line wires. If carried beyond a certain point the insulation will, however, have to be increased. In cases where the energy used is so large that it cannot be taken off the line at voltages below 1,000 volts, alternating current becomes a necessity. A current of from 100-150 amps. per contact device is just about the maximum permissible, although in some cases, especially in American practice, as much as 300 amps. have been taken off by one trolley-wheel.

8. The transformation of the high-voltage alternating currents universally used for transmission on long roads into continuous current means the installation of rotary converter sub-stations. For transformation into alternating currents stationary transformers are used, which do not call for any particular attendance and, having no rotating parts, do not show any deterioration from use.

In conclusion, Mr. de Muralt made some general remarks regarding the applicability of the two systems for traction purposes. Both systems are probably capable of satisfactorily doing the work demanded by any traction problem, but each case ought to be studied for itself in order to find out which system presents the greater advantages.

.Very irregular profile and frequent stops, especially if combined with greatly varying speeds, as found, for instance, in congested city street traffic, make a line generally more suitable for continuous current, while a regular profile, even in the case of steep grades and

long runs between stations, would make it bettter fitted for alternating currents.

Those cases are rare, however, which allow of an *a priori* decision in this respect, and a discussion on the merits of the two systems in general is a difficult thing. Attention to the fact that the Burgdorf-Thun Railway answers a whole series of questions relating to the application of three-phase alternating current to electric traction, and proves without doubt the possibility of replacing the present steam locomotive by electrically driven vehicles. This, of course, is of special interest to countries like Switzerland, possessing natural resources in the way of water-power, but large coal fields may also be put to bettter use by erecting electric central stations in their immediate neighborhood and transmitting the energy thus generated electrically to the places where it will be used on the cars.

Electricity in the Navy. *

By WALTER M. MCFARLAND.

IN discussing the applications of electricity in the navy, my remarks as to specific installations will be mainly with respect to power plants and motor installations on shore, both on account of the fact that the company with which I am identified has done virtually no ship work for the navy, and because my own duties while a naval officer had little connection with such work. My experience, however, has suggested some points in connection with the use of electric apparatus on war vessels which may be of interest and possibly may afford some information.

The use of electricity in the navy was at first for purposes connected with the torpedo service, and when electric lighting became practicable its exploitation for the navy was taken up by the officers who had been devoting their attention largely to torpedoes. After some preliminary installations had been made, a board of officers investigated the conditions for lighting on war vessels with considerable care and formulated certain rules with respect to voltage, temperature limits, etc. Until very recently the general rules formulated by that board have governed all installations on our naval vessels.

The standard voltage was put at 80, and in discussing the reason for the choice of this figure some time ago with the Naval Inspector of Electric Lighting, he informed me that it was virtually determined by the requirements of the search-lights. It had been found that it was impracticable to use two of them in series, and as they only required 50 volts each, it was felt that a higher voltage than 80 for the standard would cause too much loss due to resistance of the searchlight circuit.

The limits for temperature rise were considerably lower than have been found entirely practicable for standard practice on shore, and the explanation for using these lower limits was that the temperature conditions on board ship were much more arduous than on shore owing to the location of the dynamo room below the protective deck, which involved a very much higher initial temperature than that usually found on shore. Not to go into other details, it may be said at once that these requirements of low voltage and very low temperature limit, made the generators for naval use entirely special, with the result that unless some one concern could secure practically all the work and thus build enough of these machines to cover the development changes, naval work from a commercial standpoint would not be at all desirable. This explains why the company with which I am connected has made no effort to secure any ship work in the navy. Another large company, however, went systematically into the business of preparing to meet the demands, and as a result has installed the great bulk of electric machinery on our naval vessels. In view of the foregoing facts, it was somewhat surprising to read in the annual report of the officer having charge of electric matters in the navy a few years ago, the statement that he was in the hands of a monopoly, and that he advocated building electric machinery in the navy yards. As I told him when I once spoke to him about the matter, if the navy were satisfied to accept what everybody else found efficient and thoroughly satisfactory, there would be no trouble with respect to competition. As a matter of fact, government inspection is rigid and exacting to a degree which is not dreamed of in ordinary transactions, with the result that a machine, admirable in all respects but one, might be rejected on account of a slight excess in temperature rise in some one part. If the machines were standard in every way this would not make such a great difference, as such a trifling variation would not carry any weight with the ordinary customer; but when the machines are of such an odd voltage there is, of course, no way of selling them as they stand to any other customer, and consequently if rejected by the government they would have only a scrap value.

In the report of the Bureau of Equipment of October, 1900, it was recommended the the navy standard of voltage be raised from 80 to 110 volts, and that special dynamos of 55 volts be employed for running searchlights. The recommendation states that one of the advantages will be to increase the field of competition, and that facilities for obtaining supplies will be improved on account of the commercial voltage being 110. This, of course, is true, but it is only carrying the change half way. What should be done is to adopt the commercial standards throughout, which would enable the apparatus installed to be of the type that is steadily manufactured in large quantities at very moderate cost and for which repair parts could readily be obtained from the storehouses of the different companies located at the principal ports.

If the claims that the dynamo-rooms of war vessels are so abnormally hot as to represent conditions very much harder than any to which dynamos on shore are subjected were accurate, there would, of course, be ample justification for the low limits of temperature rise, but, as a matter of fact, there are places on shore where the temperature conditions of the dynamo-room are worse than on naval vessels. I have in mind a case where there was some delay in testing an installation in which I was interested, and the reason given for the delay was that the engineers who were to make the test were unwilling to stay in the dynamo-room long enough during the summer season to make the test, and insisted on waiting until cold weather had set in. Anyone familiar with conditions obtaining on shore can undoubtedly cite cases in his own experience where the temperature of the dynamo-room would run up to 140 or 150 degrees at times, which is a higher temperature than I have ever heard cited for the dynamo-rooms of naval vessels. In all these cases, standard machines with the usual limits for temperature rise have given satisfaction.

There is another very decided objection to the use of non-standard apparatus due to the low limits specified for temperature rise, namely, that the machinery must inevitably be considerably heavier. This is a point which appeals to me very strongly, on account of the fact that the main machinery in naval vessels is rigidly limited in weight, and the unfortunate contractor is compelled to pay a penalty for all overweight. It always seemed to me absurd that when such vitally important things as the propelling engines for driving the ship had a weight limit put upon them, the electric equipment was either not limited or, on account of peculiarities in the requirements, was allowed to be much heavier than it might have been if made according to the best standard practice.

As you are all aware, the use of electricity on board ship for power has been of comparatively recent introduction, the first important case being the turret-turning machinery of the *Brooklyn*, which was installed about 1896. This was followed by the more elaborate installations on the *Kearsage* and *Kentucky*, where all the turrets were turned electrically and motors were also used for ammunition hoists, boat winches, ventilating blowers, and some other purposes. While I have not personally served on board of ships with electric power apparatus I understand that it has generally given satisfaction.

Among the chief reasons which appeal to the layman as well as the engineer for the use of motors rather than steam engines is the absence of long lines of piping, which unduly heat the spaces through which they pass in hot weather, and the avoidance of the chance of leakage. It would seem that on this line of thought, the two places of all others where motors should have been installed are for the capstan and steering engines, but while there have been a few officers in the navy to advocate this, the concensus of opinion has been against it. I do not know the exact reasons assigned further than a sort of dread that the motors would be unreliable, but I presume that where the objection was made by officers acquainted with electric apparatus, it was due to the fear that in both of these places there would be times when the motor would be brought up standing under load, and under such circumstances direct current motors, unless protected by external safety devices, would be burned out, and these external devices would add to the complication and chance of derangement. It is undoubtedly a fact that both the capstan and the rudder are at times subjected to

* A paper presented at the 166th meeting of the American Institute of Electrical Engineers, at New York, May 28th, 1902.

conditions where the motive power will be brought up standing, so that unless safeguards were provided there certainly would be danger of serious damage.

This last consideration leads me to bring up the point of the adaptability of alternating current apparatus to use on shipboard. Indeed, I may say that although I had thought about it a great deal myself, the question was asked me by a naval officer during a recent visit to one of our large battleships, why alternating current was not used. Of course the immediate answer is that the naval authorities in charge of electric apparatus still limit all electric machinery on shipboard to that operated by direct current. It seems to me, however, that the conditions on shipboard are such as to make the points which constitute the advantages of alternating over direct current apparatus of unusual weight. From the very nature of things the electric apparatus is to a considerable extent handled by men without a great deal of skill, a point to which attention has been called by the chief of the Bureau of Equipment in some of his annual reports, where he laments that the supply of trained men is not sufficient. Further than this, the induction motor with its extreme simplicity and ability to withstand abuse and neglect seems much better adapted to the general run of conditions on board ship than the more delicate direct-current motor. With its ability to stand a tremendous overload and even temporary stoppage, it would answer for driving capstans and steering gear, from which the direct current motors have thus far been barred out. It would also seem admirably adapted for such work as driving the forced draught blowers for the fire-rooms, which are usually located in almost inaccessible places and where the steam engines now used to drive them can rarely receive adequate attention when the blowers are driven at full power. Only recently I heard one of the ablest engineers in the navy comment on this very point, of the adaptibility of the induction motor for this particular service. The only objection to the use of alternating current that occurs to me is the requirements in searchlights, but, as I remarked above, it is already proposed to install a special generating set even where direct current is used, to supply the searchlights, and it will be perfectly practicable to put in a motor generating set giving direct current for searchlights, while alternating current would be used elsewhere.

While speaking about this use of motors in the department of the propelling machinery of the vessel, it seems pertinent to call attention to the fact that claims have been made for the adaptibility of motors to drive the motive machinery which seem ill-advised. These claims are based largely on tthe admitted high steam consumption of many of the steam auxiliaries against which a much lower steam consumption could be figured where these same auxiliaries were driven by motors. The fact must not be overlooked that on war vessels, as at present designed, the dynamo room is at a considerable distance from the boilers, involving long lines of steam and exhaust piping, while the steam auxiliaries in engine and fire-rooms are so situated that the steam and exhaust connections to them are very short. Further than this, while the steam consumption of these auxiliaries, considered alone, is undoubtedly very high, the fact was overlooked by those advocating the use of motors, and who were not familiar with the details of propelling machinery, that provision has for some years been made for turning the exhaust from these auxiliaries either into the receivers of the main engine, or into the feed water heater. In either case the steam expenditure was enormously reduced and the heat in the steam utilized to the fullest extent possible, under which circumstances their steam consumption per horse-power would be lower than that with the motor drive. It is sufficient to note that where the steam is turned into the receiver, the cylinders of the auxiliary become in effect an extension of one of the cylinders of the main engine and, consequently, the steam consumption becomes the same as that of the main engine, which even at reduced power is considerably below that of the small engines driving the dynamos.

There are enough places on board ship where motors can be used with great advantage, convenience and economy to make it unnecessary to urge their installation in places where they could not hope to give the satisfaction that is given by the steam auxiliaries, with respect to speed regulation, economy and weight.

My attention was recently called by a prominent officer of the navy department to a proposition made for sub-dividing the dynamo-room and having two, located in different parts of the ship, with the object of preventing the complete disablement of such vitally important things as the turrets and ammunition hoists in the event of a shell getting into the one dynamo room as now arranged. I was very much surprised to learn that objection had been made to this on the score of complication, and I cited the case of the Explotadora system in Mexico, where there are seven a. c. generating stations scattered along the mountain side at distances of from ten to twenty miles from the receiving station, where the current from the different stations is brought together on the same bus-bars and transmitted to the city of Mexico. It seems to me that this proposition is an eminently sound one, and while there would of course be a slight increase of complication, it would be as nothing compared with the increased safety against total disablement.

Installations on Shore.—Naval requirements for electric machinery on shore are practically for standard apparatus, so that here the criticisms which I have made do not apply. Each bureau decides on the apparatus which it deems best for its own purposes, and all who make apparatus of the class wanted have an opportunity to bid. This brings up the natural inquiry from those not familiar with naval matters as to why there should not be a central plant for each navy yard supplying all the current needed for use in the yard, whether for lighting or power. The reason why this has not obtained is, primarily, that all of our large navy yards have been established for some time, and that they were at first entirely steam-driven plants. As the yards are of large area, with the different shops scattered, it was, of course, the best practice at the time they were laid out to have individual power plants for each set of shops. Under the existing system of appropriations some bureaus were able to install an electric drive earlier than others, and in this way we have the present condition, where in a single navy yard there may be several power plants, each for its own particular set of shops. I think there is little doubt that in any new yards that are established the tools will be entirely motor-driven and the current will be derived from one or more power plants. I say one or more, because it would depend on the location of the yard. Where a yard is isolated, as in the case at Mare Island near San Francisco, or the proposed station in the Philippines, it would seem unsafe to put the whole power plant in one locality, for the reason that any damage such as that caused by a fire, earthquake, or other disaster, would lay up the whole yard. Where a navy yard is near a large city or other establishment having a large power plant, arrangements could probably be made, in case of damage to the yard's power plant, to rent current for a time.

Most of the apparatus installed in the navy yards is of the direct current type, probably because the earlier installations were made before the induction motor had become so prominent as it has in recent years, and consequently as installations were increased the direct current was necessarily adhered to. In some recent plants, however, while direct current is used, the installation has been on the three-wire system from a single generator on the Dobrowolski system. This has enabled larger and fewer units to be used, with resulting satisfaction.

In two very interesting plants alternating current has been used, with induction motors of course, the first at the ordnance proving grounds and powder factory, at Indian Head, Md., and the other at the steam engineering plant at the Brooklyn Navy Yard.

At Indian Head the induction motors commended themselves on account of their simplicity and absolute immunity from sparking, but as it was desired to have a short line of railway with an electric locomotive for hauling guns from tthe dock to the proving range, and for other purposes, some direct current was also necessary and the generators installed are of the double-current type. The railway is driven by what is known as the "button system," or electromagnetic traction system. It was undesirable to have overhead wires, and an underground trolley would also have been objectionable, while the button system answers the requirements of the case admirably. This plant has been installed about three years and has given great satisfaction.

The plant at the Brooklyn Navy Yard has been only recently put in operation, although the contract for it was made in 1899, the delay being due to the fact that the power house was not completed until last fall. In this case the Bureau of Steam Engineering detailed an officer who visited important manufacturing establishments all over the country to find the general opinion as to the best type of apparatus to install. He also visited various electrical manufacturing concerns to discuss with their engineers the merits of the different systems. As a result of his report, it was decided to use alternating current generators with induction motors for the tools, and the

plant is an excellent illustration of the most advanced practice in the powering of a modern engine-building plant. Just about the time when this contract was placed, the large ship and engine-building establishment at Camden, N. J., known as the New York Shipbuilding Company, was also considering the question of electric driving, and after going into the matter very carefully under the guidance of a prominent electrical engineer, also decided for alternating current with induction motors. In this plant there is an unusually large number of cranes, and as the crane builders generally charge a considerably higher price for alternating current cranes, it was decided to drive them by direct current. As a result, the two 500-kw generators are of the double-current type, like the much smaller ones at Indian Head.

A comparatively new field for the application of electricity in the navy yard is in the dry-dock machinery, and in all the contracts made since the early part of 1899, it has been arranged that the pumps are to be driven by motors and that the capstans and winches around the docks are also to be electrically driven. Power drive for the latter would be practically impossible except by the use of electricity. Thus far all of these installations have been by direct current, but I believe there is little doubt that as the naval authorities who have charge of these matters become more familiar with the advantages of alternating current apparatus, this form will be used, because it seems much better adapted to the circumstances of the case than direct current.

Naval work on shore where electricity can be applied is largely in the nature of manufacturing and repair establishments, and consequently we should expect that the equipment which commercial manufacturers find to give them the best results would be adopted for the navy. This is, indeed, the case, and just as no large manufacturing establishment under private auspices now dreams of using anything but the electric drive for its tools, so the same thing is true of naval establishments.

With respect to the application of electricity on shipboard, the circumstances are such as to give a very promising field for the application of electricity, and my own opinion is that if alternating current were adopted there would be a much greater number of motors installed than at present.

Electricity on Warships—I.

In a paper read at the recent special May meeting of the American Institute of Electrical Engineers, Lieut. Harry George, of the U. S. Navy, described in detail the electrical equipment of war ships. Mr. George considers that the advantage of the electric drive for shipboard auxiliaries appears to be as evident as the superiority of the incandescent lamp over the oil lamp or candle for illumination. The confidence engendered by the use of electricity in the early ships and the rapid commercial development of motors and their controlling apparatus gave an impetus to the use of the electric drive on shipboard, and at the present time we find motors installed for ventilating blowers, ammunition hoists, turret turning, elevating and loading of guns, workshop machinery, and the handling of boats and heavy weights. Steam or hydraulic power for auxiliary power has been relegated to the background, and the day is not distant when auxiliary machinery of all descriptions will be operated by electricity.

The motor is peculiarly adapted to ships' use. Compared with steam, the cutting of bulkheads and decks is reduced to a minimum, and hence the water-tight system is more efficient, the circuits may be better protected than in the case of steam pipes and offer a smaller target. The cutting of a circuit by shot involves no danger to the personnel, and to surrounding appliances, and in case of accident is more readily repaired. There is no leak from joints and valves, and no appreciable loss of energy in elbows and turns. No loss by condensation; and much less by radiation. The motors are more efficient and there is relatively less loss in small motors than in small steam engines, they are less liable to get out of order, there are no reciprocating parts to adjust and their operation is simpler and requires less supervision.

The advance of electricity for naval purposes may be illustrated by a comparison between the electric plant of the "Indiana," one of our first battleships, completed and commissioned in 1895, and the "Kearsarge," one of our latest battleships, commissioned in 1900. The displacement of the "Indiana" is 10,200 tons, and she is equipped with three 24-kw, 80-volt generators for supplying current to 500 incandescent lamps, four 60-centimeter search-lights, two 2-hp ventilating motors for dynamo room, four ¼-hp portable ventilating blowers, with winches and ammunition hoists, covering about 36 hp, or a total output of 67 kilowatts, about 7 watts per ton of displacement.

The "Kearsarge," with a displacement of 11,525 tons, is provided with seven 50-kw generators, compound wound, direct-connected, 80 volts, to supply the following demand for lighting and power:

	Watts.
700 incandescent lamps	48,000
Four 30-in. search-lights	6,000
Ventilating motors and portable fans	98,000
Ammunition hoists and whips	115,138
Training, elevating and rammer motors	171,580
Boat cranes and winches	216,350

or a total of 665,240 watts, or approximately 57 watts per ton of displacement.

In this connection the practice abroad is shown in representative vessels of the German, Russian and French navies:

GERMANY.

"Furst Bismarck."—Battleship, 10,650 tons displacement, with an electric generating plant of 325-kw output, supplying current to 900 incandescent lamps, 44 motors for ventilation, drying room, ammunition hoists, gun training gear, coal winches, refrigerating plant and search-lights.

"Kaiser Frederick III."—Armored cruiser, 11,130 tons displacement. Five generators, with output of 324-kw supplying power in watts as follows: Incandescent lighting, 38,260; search-lights, 55,500; ventilation, 28,340; ammunition hoists, 78,440; gun training gear, 8,880; coal winches, 7,400; refrigerating plant, 4,500.

RUSSIA.

"Retvizan."—Battleship, built at Cramps Shipyard, Philadelphia, Pa. Electric installation, three 132-kw, four 66-kw and one 60-kw generators as a maximum output of 588 kilowatts. These generators supply current to 1,167 incandescent lamps and six 30-in. projectors, and the following auxiliaries:

4 turret turning motors.
4 elevating motors.
4 rammer motors.
4 turret ammunition hoists.
12 60-in. blowers for forced draft system.
18 motors for hull ventilation.
6 pump motors.
2 boat crane motors.
1 capstan motor.
8 ash hoist motors.
1 steering motor.
30 ammunition hoist motors for battery.
2 submerged torpedo motors.
1 workshop motor.
1 torpedo lathe motor.
1 bread mixing motor.
1 laundry motor.

Also a number of portable fans, helm indicators and other electrical signaling devices.

FRANCE.

"Jena."—Battleship, 12,052 tons displacement. Two generators of 98.4-kw capacity, and two of 49.2-kw capacity; total output, 295.6 kilowatts.

The general subject of electrical installations was taken up under the following headings: Dynamo Rooms and Accessories, Generators, Circuits, Wire and Wiring Appliances, Motors, Interior and Exterior Signaling or Communicating Systems, Search-lights and Incandescent Lamps.

DYNAMO ROOMS.

For security in time of action, the dynamo room is located below the water line underneath the protective or armored deck, in close proximity to the source of steam supply. The chief considerations are protection, ventilation, accessibility and a central position for the economical distribution of electrical energy. The compartment assigned to the dynamos may be a single one between transverse water-

tight bulkheads, or may consist of two or more such compartments in the larger vessels. In the U. S. S. "Alabama" there are four dynamo rooms between two transverse water-tight bulkheads. The dynamo room is generally provided with its own ventilating system, and contains the switchboards, search-light panels, rheostats, tool boards, work benches, oil and waste tanks and the accessories necessary for the efficient operation of the plant.

Heretofore, the dynamos have been located in the same portion of the vessel, the dynamo rooms forming subdivisions of one general compartment between transverse water-tight bulkheads. The rapid development of the electric drive and its application to ammunition hoists and gun operation has made the question of dynamo rooms and their location one of the most important in ship design. In the proposed 16,000-ton battleships, recently authorized by Congress, it is proposed to install the generators in two separate compartments, each dynamo room to be entirely independent of the other electrically, and to be situated at opposite ends of the vessel. Each dynamo room is to be supplied with four 100-kw sets, which will supply the output necessary to handle the battle load, for lighting and all auxiliaries. All forward circuits will be supplied by a distributing board located near the forward dynamo room but separated from it; all after circuits from the after distribution board, similarly situated. By suitable transfer switches both the distributing boards may be electrically connected and the entire load thrown in either dynamo room at will. This will increase the military efficiency of the installation, as in case of accident rendering either dynamo room uninhabitable, the battle load may be thrown on the remaining room.

Tandem compound engines for driving the dynamos have been used extensively, and were first installed on the U. S. S. "Chicago." They have given excellent results, although not as efficient nor as accessible as the cross-compound engine required by the present specifications. The excessive height of this type of generator, not only assembled, but the additional head-room necessary to remove pistons and rod, prohibit their use in naval installations with the comparatively small height between decks. Fifty kilowatts would seem to be the maximum capacity allowable in generators of this design, and they could only be used in a majority of vessels by making special provision for the removal of pistons.

Lubrication in the steam spaces is not allowed, as the auxiliary boilers in some cases have been injured and the crown sheets dropped in spite of the precaution of removing oil from condensed steam. To further lessen the liability of oil working into the cylinders, the stuffing boxes are specified to be at least as long as the length of stroke of engine. These boxes are to be accessible from the outside of the enclosing casing of the engine to facilitate adjustment.

Forced lubrication is an essential factor in attaining satisfactory operation of a generator, and is now required on all sets furnished the navy. A pressure of from 10 to 20 pounds is prescribed in the lubricating systems, but the bearings are to be so designed that forced lubrication is not a necessary feature to insure cool running.

The smaller sets, 2½ and 5 kw, for torpedo boats and destroyers are designed for high speed, in order that reduction in weight may be attained. This involves a rather uneconomical steam consumption, but inasmuch as these sets are not subjected to continuous running as in battleships and cruisers, the increased weight of steam required for their operation is not considered in the attempt to reduce all torpedo boat weights to a minimum.

The 2.5-kw sets give an output of 5 watts per pound; the 5-kw sets, 3.865 watts per pound, although some 5-kw sets have been installed with an ouput of 5 watts per pound weight of set.

The 16-kw sets, although of comparatively high speed (400 to 500 r. p. m.) show a weight efficiency rather lower than would appear consistent with other types. These sets give 2.86 watts per pound, whereas the 32-kw sets give 3.14 watts and the 100-kw sets 4.55 watts per pound. The specified water consumption of all sets is rather liberal, as it is the aim to secure fair efficiency with great durability, and sacrifices are made to ensure the latter characteristic in naval installations.

Generators have improved step by step with the commercial type, and the specifications now in force embody no requirements that are not fulfilled by the best types of commercial machines, excepting that the rating of these generators must be changed to conform to the specified heating limits and overload requirements. An allowable temperature rise of 33½° C. in armature appears at first sight rather low, but taking under consideration the high temperatures in many of the dynamo rooms in tropical service, the low heating limits assigned are justifiable.

The specifications require that the speed variation must not exceed 2½ per cent. when load is varied between full load to 20 per cent. full load, gradually or in one step, engine running with normal steam pressure and vacuum. A variation of not more than 3½ per cent. will be allowed when full load is suddenly thrown on or off the generator, with constant steam pressure either normal, 20 per cent. above, or 20 per cent. below normal, and exhaust either to condenser or to atmosphere. No adjustment of the governor or throttle valve during the test shall be necessary to ensure proper performance under any of the above conditions. The engines are required to operate satisfactorily without the use of lubricants in the steam spaces. The lubrication for all other working surfaces is of the most complete character, not depending on squirt-can lubrication. Forced lubrication is used wherever practicable, which includes engine shaft, crank pins, crosshead bearing, eccentric, etc.

Massachusetts Electrical Systems In 1901.—Finances.

BY ALTON D. ADAMS.

ELECTRIC lighting companies in Massachusetts, doing only an electrical business, had issued capital stock to the par value of $12,764,351.62 on June 30, 1901. This amount is greater by 8.5 per cent. than the capital of these companies on June 30, 1900. At the close of the fiscal year first named the bonds of these companies outstanding amounted to $3,615,100, and the notes payable to $2,965,662.75. These figures show a decline during the year of 6.2 per cent. in the amount of bonds, but an increase of 46.9 per cent. in the notes payable.

At the close of the fiscal year under consideration all the gas companies of the State had outstanding $18,796,500 in stocks, $2,168,250 in bonds, and notes payable to the total of $5,456,382.01. Measured by issues of stocks, bonds and notes, the investments of the gas are thus greater than those of the purely electric companies, but thirteen of the gas companies in cities and nine of these companies in towns operate electric as well as gas plants. It is not possible to state just how much of the investment of the gas companies is represented in their electric plants.

The surplus of the purely electric companies was $2,735,270.74 at the date first mentioned, an increase of 22.3 per cent. over the surplus for the previous year. The surplus just named for 1901 was 21.4 per cent. of the capital of the electric companies.

All of the central electric lighting stations in the State, by whomsoever operated, earned an income of $6,217,804 during the year of 1901, and this amount exceeded that for the previous year by 9.5 per cent. Of this income 99 per cent. was from sales of electrical energy, and the remaining one per cent. from the rent of meters and motors and from steam heating. The income from sales of electrical energy, amounting to $6,159,205.59, was made up of 8.8 per cent. from service to commercial arc lamps, 3.5 per cent. from commercial incandescent lamps operated at contract rates, 44.0 per cent. from incandescent lamps at meter rates, 22.9 per cent. from public arc lamps, 5.7 per cent. from public incandescent lamps, and 14.9 per cent. from electric power. It thus appears that 28.6 per cent. of the energy income was from public and 71.4 per cent. from private service. The income from electric street lamps amounted to $1,764,176.77.

In this same year the total sales of gas amounted to $7,057,858.52, and only $172,828.75 of this sum was derived from gas street lamps. It thus appears that the income from sales of electrical energy was 87.2 per cent. of that from gas, but that gas street lamps yielded only 9.8 per cent. as much income as electric street lamps.

During the fiscal year of 1901 the total expenses of all electric lighting systems were $3,922,403.08, or 63 per cent. of the gross income. These expenses were greater by 10.6 per cent. than the amount for the previous year. Of the total cost of operation, 49.1 per cent. was expended at the stations, 24.1 per cent. in distribution, 13.0 per cent. for office expenses and management, and 13.6 per cent. for miscellaneous expenses. The expenses of operation at the stations amounted to $1,929,605.43. Of this sum 48.4 per cent., or $934,448.20, went for fuel. The percentage of this fuel item was 23.8 compared with the entire expenses of the electric systems, showing that efficiency of operation might be increased with marked advantage.

Other expenses at electric stations were: for rent of real estate, 3.2; oil and waste, 2.2; water, 3.0; wages, 28.2; repairs of station, 2.2; steam plant repairs, 6.7; electric plant repairs, 5.0, and appli-

ances, 0.6 per cent. of the total cost of operation there. When the total expenses are deducted from the entire earnings of operation of electric systems, as just given, there remains a net profit of $2,295,401.74 for the year. Of this amount the electric stations operated by gas companies earned $342,056.17, so that there remains the sum of $1,953,345.57 as net profits for the purely electric companies. In addition to earnings previously stated, these electric companies received $356,302.02 from rents, jobbing, and other sources, which, added to the sum last found, gives a total net profit of $2,309,647.59 for the electric companies. From this sum there was deducted $314,512.49 for the payment of interest and $464,269.06 for sundry other items, leaving $1,530,378.53 that might be devoted to either depreciation, surplus or dividends, at the election of the companies.

This $1,530,378.53 equals 11.9 per cent. on the $12,764,351 of capital stock issued by the electric companies. As a matter of fact, the sum of $1,006,350.57 was paid in dividends, leaving $524,027.96 for surplus and depreciation charges.

On June 30, 1901, the electric lighting stations of Massachusetts contained 928 dynamos, including 114 power generators. The total capacity of these dynamos amounted to 69,434 kilowatts, of which 12,234 kilowatts were in arc and 43,097 kilowatts in incandescent dynamos, and 14,103 kilowatts in power generators. The average capacity was 74 kilowatts each. From these figures it appears that the power generators represented 20 per cent., the arc dynamos 17 per cent., and the incandescent dynamos 62 per cent. of the total station capacity.

The increase of capacity for all dynamos during the year was only 493 kilowatts, the smallest amount added in any year since 1883. Only the incandescent dynamos gained in capacity during the year, and their increase amounted to 1,384 kilowatts. Meantime the arc dynamos lost 439 and the power gnerators 452 kilowatts of capacity.

The decrease in capacity of arc dynamos began in 1900, and is no doubt due to the substitution of service from incandescent or constant-pressure machines, particularly by the use of constant-current transformers. Decline in capacity of power generators seems to be due to the removal of such machines from electric lighting stations, where they have been employed to supply power for street-car motors, to separate street railway plants.

At the close of the year under consideration the steam engines in electric lighting stations numbered 344, so that there were 2.7 dynamos to every engine on an average. These 344 engines had a combined capacity of 89,348 horse-power, and the average capacity was 260 horse-power each. The capacity of all dynamos in electric lighting stations, reduced to horse-power, is 93,075, so that the ratio of dynamo to engine capacity was 104.1 per cent.

Besides the engines, electric lighting stations contained 42 water-wheels, with an aggregate capacity of 9.432 horse-power, or 224.5 horse-power each on an average.

The combined rating of steam engines and water-wheels in electric lighting stations was 98,780 horse-power, and of this capacity the water-wheels represented 9.6 per cent. These stations contained 359 steam boilers, with a total rating of 60,323 horse-power at the close of the year. The average rating of these boilers was thus 168 horse-power each. It may be noted that the number of boilers exceeds that of engines by 4 per cent., but the engine rating is greater than that of boilers by 48 per cent. Evidently there is less tendency to large sizes in boilers than in engines. As a boiler horse-power is usually based on the delivery of 30 pounds of steam per hour, while an engine should consume steam at a less rate, the boilers may have been able to operate all the engines.

There were 7,967 electric motors connected to the circuits of lighting stations at the close of the fiscal year under consideration. Of these motors 5 were on circuits operated by arc dynamos, 5,230 were on incandescent circuits, and 2,732 motors were supplied from electric power generators. Fan motors are not included by these figures. The increase in the number of motors during the year was 1,649, and this number was made up by the addition of 160 motors to power circiuts, 1,495 to incandescent circuits, and the loss of six motors from arc circuits. The 7,967 motors had a combined capacity of 31,426 horse-power, corresponding to an average of 3.9 horse-pewer each. The number of motors on power circuits was 34 per cent., and that on incandescent circuits 65 per cent. of the total. Motors added to the service of lighting stations during the year had a total capacity of 4,293 horse-power, an increase greater than that in any other year, except that of 1900, in the history of the State.

Of the combined capacity of all the motors in Massachusetts on the circuits of lighting stations Boston had 56 per cent. in 1901. The number of these motors for Boston was 4,793, and their total capacity 17,785 horse-power. These motors were made up of 5 on arc circuits, 1,086 on power circuits, and 3,702 on incandescent lines. For all these motors the average horse-power was 3.7. During the year 1,279 motors were added to the circuits of lighting stations in Boston, and the capacity of these motors was 2,826 horse-power, or 2.2 horse-power each on an average. This increase in the number and capacity of motors at Boston was greater than that of any previous year.

Electric lighting systems included among their equipment 25,779 arc lamps throughout the State in the year under consideration. Of these lamps 2,280 were single open arcs, 7,787 were double open arcs, and 15,712 were enclosed arcs. During the year the number of single open arcs declined by 635 and the number of double open arcs by 665, but the number of enclosed arcs went up by 3,724. The net result of these changes was a gain of 2,424 in the total number of lamps. The most notable feature of this showing is the rapid conquest of the field by enclosed arcs. Circuits of lighting stations were supplying 11,219 commercial arcs and 14,080 arc street lamps at the close of the year, a total of 25,299 lamps. The difference between this total and that previously given for all arc lamps of lighting systems seems to be due to the fact that all arc lamps owned by lighting stations are not in constant use. Arc street lamps formed 55 per cent. of the total number of street and commercial arcs.

Commercial arc lamps increased in number by 1,417 and street arcs by 618 during the year. In Boston the total number of arc lamps was 8,434, or about one-third of that for the entire State. Of these lamps 303 were single open arcs, 308 were double open arcs, and 7,823 were enclosed arcs. It follows that more than one-half of the enclosed arcs in the State are at Boston, where they have displaced nearly all of the other types.

Where the rating of arc lamps was given in candle-power, the energy capacity of lamps has been computed on the basis of 0.25 watt per nominal candle-power. In cases where lamps were rated in amperes, the figures for amperes have been multiplied by 80 to get the watt capacity per lamp. Results obtained in this way are not highly accurate, but probably involve no serious errors. The numbers of commercial arc lamps for each of the several ratings are as follows:

Candle-power.	Number of lamps.	Candle-power.	Number of lamps.
800	6	1,400	105
1,000	9	1,600	61
900	9	1,800	2
1,200	2,004	2,000	4,314
1,300	2	4,000	6

Ampere rating.	Number of lamps.	Ampere rating.	Number of lamps.
3	448	6	1,069
4	825	7.5	7
4.5	131	8	8
5	2,174	10	27
5.5	10	18	2

Of the total number of commercial arc lamps 18 per cent. were rated at 1,200 candle-power, and 44 per cent. were rated at 2,000 candle-power each. Lamps with a rating of 4 amperes formed 7 per cent., lamps rated at 5 amperes 20 per cent., and lamps rated at 6 amperes 9 per cent. of the total number of commercial arcs.

The combined capacity of all commercial arc lamps at the close of the year was 4,672 kilowatts, on the basis already stated. Of this total, 1,200 candle-power lamps represented 13 per cent., and 2,000 candle-power lamps 46 per cent. Lamps of 1,200 candle-power represented 601 kilowatts, 2,000 candle-power lamps 2,157 kilowatts, 5-ampere lamps 869 kilowatts, and 6-ampere arcs 513 kilowatts.

Arc street lamps were divided among the several ratings as follows:

Candle-power.	Number of lamps.	Ampere rating.	Number of lamps.
1,200	6,509	5.5	6
1,500	2	6	325
1,600	20	6.6	122
2,000	7,089	7.5	1

Of the total number of arc street lamps those rated at 1,200 candle-

power formed 46 per cent., and those rated at 2,000 candle-power were 50 per cent. The capacity of all arc street lamps was 5,732 kilowatts, and of this 1,952 kilowatts was in 1,200 candle-power, and 3,544 kilowatts in 2,000 candle-power arcs.

Commercial incandescent lamps connected to the circuits of lighting stations throughout the State numbered 1,117,707 at the close of the fiscal year. The number of these lamps of each candle-power was as follows:

Candle-power.	Number of lamps.	Candle-power.	Number of lamps.
4	377	24	598
6	999	25	35
8	3,097	30	6
10	4,564	32	248
12	1,759	50	22
14	6	65	1
16	1,103,133	150	27
20	2,835		

Lamps of 16 nominal candle-power far outnumbered all others, standing at 1,103,133. Next in importance come lamps of 8 and 10 candle-power.

In this same year 18,301 incandescent street lamps were operated by the lighting stations of Massachusetts.

The numbers of these street lamps were distributed among the different candle-powers as follows:

Candle-power.	Number of lamps.	Candle-power.	Number of lamps.
15	219	32	1,482
16	169	40	530
20	861	50	23
24	168	64	9
25	14,001	65	17
30	821	75	1

Of all the incandescent street lamps 14,001, or 76 per cent., were of 25 nominal candle-power. The size of next importance is the 32 candle-power, with 1,482 lamps.

Allowing 3.5 watts per nominal candle-power, the 1,117,707 commercial incandescent lamps have a combined capacity of 62,419.5 kilowatts. Of this capacity the 16 candle-power lamps alone represented 61,775.4 kilowatts, or 99 per cent. Making the same allowance per candle-power, the 18,301 incandescent street lamps have a total capacity of 1,656.9 kilowatts. Of this total the 25 candle-power street lamps represent a capacity of 1,225 kilowatts, or 74 per cent. Adding the figures for incandescent lamps in street lighting and commercial service, their total capacity amounts to 64,076.4 kilowatts. The 62,419.5 kilowatts of commercial incandescent lamps represent 97 per cent. of this total capacity

At the end of the fiscal year electric lighting systems had 105,601 poles set in streets throughout the state, and 4,440 poles set on other property, a total of 110,041 poles. With 50 poles per mile, this number of poles would suffice for 2,200 miles of pole line.

At the same date the electric lighting systems included 1,128,907 feet, or 214 miles, of underground conduit. It thus seems probable that the length of underground conduits was about one-tenth that of pole lines. The total length of wire in underground conduits was 8,177,364 feet, so that each conduit carried 7.2 wires on an average. Assuming an efficiency of 74.6 per cent. for all electric motors, their total capacity in kilowatts is represented by the number previously given for their horse-power capacity. The capacities of the several elements of the connected load of lighting stations are combined to determine their total capacity:

Arc street lamps	5,732	kilowatts
Incandescent street lamps	1,656	"
Commercial incandescent lamps	62,419	"
Commercial arc lamps	4,672	"
Electric motors	31,426	"
Total connected load	105,905	kilowatts

Dividing the income of $1,410,812.06, derived from arc street lamps, by the number representing the kilowatt capacity of these lamps, shows the income per kilowatt of their capacity to have been $246. Incandescent street lamps earned $353,364.71 during the year, or $213 per kilowatt of connected capacity. Income from commercial incandescent lamps amounted to $2,927,774.03 during the year, and this sum corresponds to $45 per kilowatt of their connected capacity. The earnings of commercial arc lamps were $545,468.75, and the average income per kilowatt of their capacity was therefore $117. Service to electric motors brought $921,786.04 to lighting stations, or $29 per kilowatt of motor capacity. Considering the entire connected load, the income was $58 per kilowatt. Public lighting yields a larger rate of income than private service per kilowatt capacity of connected lamps, in part because street lamps are operated more hours per year than are private lamps.

Of the 105,905-kilowatt capacity of lamps and motors connected to lighting systems the percentage in arc street lamps was 5.4, in incandescent street lamps 1.6, in commercial incandescent lamps 59, in commercial arc lamps 4.4, and in electric motors 29.7.

As the total capacity of dynamos in lighting stations was found to be 69,434 kilowatts at the close of the year in question, the connected load of 105,905 kilowatts in lamps and motors was 1.52 times this dynamo capacity.

Special May Meeting of American Institute of Electrical Engineers.

A special meeting of the Institute was held in the hall of the American Society of Civil Engineers, 220 West Fifty-seventh Street, New York City, on Wednesday, May 28, for the purpose of discussing the general subject of Electricity in the Army and Navy. Two hundred and fifteen members and guests were present, President Steinmetz being in the chair.

The following papers were presented: "Electricity in the Signal Corps," by Lieut.-Col. Samuel Reber, United States Army; "Emergency Engineering for Harbor Defense," by Dr. Louis Bell, of Brookline, Mass.; "Electricity in the Navy," by Mr. Walter McFarland (late United States Navy), of the Westinghouse Electric Manufacturing Co., Pittsburg; "Electricity in the Navy," by Lieut. Harry George, United States Navy; "The Reasons for the Change of the Navy Standard Voltage from 80 to 125," by Lieut. W. Van N. Powelson, United States Navy; "The Military Cable System of the Philippines," by Capt. Edgar Russel, Signal Corps, United States Army; "Submarine Cable Testing in the Signal Corps, United States Army," by Mr. Townsend Wolcott, of New York; "Wireless Telegraphy—United States Navy," by Lieut. A. M. Beecher, United States Navy; "Electricity in its Application to Submarine Mines," by Capt. John Stephen Sewell, United States Army; "Civilian Co-operation in the Development of Electrical Devices for Military Purposes," by Mr. Caryl D. Haskins, of the General Electric Co., Schenectady, N. Y.; "Electricity in Permanent Seacoast Defense," by Major George W. Goethals, United States Army.

The papers of Col. Reber, Captain Russel and Mr. Wolcott were supplemented by an exhibition of lantern slides. The discussion was participated in by Col. Reber, Lieut. George, General Griffin, Mr. Abbott, Lieut. Beecher, Mr. Hanchett and Gen. Greeley.

The paper by Caryl D. Haskins on "Civilian Co-operation in the Development of Electrical Devices for Military Purposes" set forth the desirability of closer co-operation between civilian electrical engineers and officers of the United States Army and Navy. Referring to the fact that the details of mining systems have been regarded necessarily as an official secret of a certain branch of the army service, he considered that nevertheless proper official secrecy does not bar the mining system from such benefits as might result from civilian co-operation. The rapid and accurate transmission of angles in connection with base line, range and position finding is, in particular, a field in connection with which civilian engineers of wide experience might be of material aid. Another field in which such engineers might be of material aid. Another field in which such engineers might be of material service is in connection with the elaboration of plans, and in the locating of materials, for emergency projects. Mr. Haskins considers that some comprehensive plan should be elaborated for the finding, organizing and concentrating of a volunteer force of trained electricians, officered in part by electrical engineers, and commanded by officers from that branch of the regular establishment responsible for work under execution. A systematic study of this problem will almost certainly result in recommendations for the establishment of a permanent reserve force, possibly taking

the form of a national militia and comparable with the Royal Volunteer Electrical Engineers of Great Britain. It is even conceivable that such a system might very properly be in the form of a skeleton organization attached to the regular establishment.

Lieut. Col. Samuel Reber, in his paper entitled "Electricity in the Signal Corps," devoted attention more particularly to the special telegraph and telephone apparatus employed for fortress and field work, the main characteristics of which are compactness and portability. The paper contains illustrations of several forms of such apparatus. A field searchlight equipment was also described.

Mr. Townsend Wolcott read a paper on "Submarine Cable Testing in the United States Signal Corps," which was prefaced by the statement that the methods used are not peculiar to the testing of government cables. The chief features of the method are a preliminary breakdown test at a high voltage, followed by the time-honored measurements of electrostatic capacity, insulation and conductor resistance, these comprising the electrical testing. The armor is submitted to mechanical tests, and there is a chemical test for galvanizing; while other materials entering into the cable may be subjected to test, their quality can usually be determined pretty well simply by inspection. Mr. Wolcott in his paper gives in detail the methods of applying the above tests in the inspection of submarine cables for the United States Signal Corps.

Capt. Edgar Russel, of the United States Signal Corps, gave an account of the military cable system of the Philippines. A table shows that there are now in the Philippines forty-one cable stations, with 1,297 miles of cable connecting the same. A historical resume is given of the development of the Philippine cable service, with accounts of some of the cable-laying expeditions. The paper includes some illustrations of cable instrument circuits.

Capt. John Stephen Sewell, of the United States Army, presented a paper on "Electricity in its Application to Submarine Mines," in which some hints are given of the manner in which such mines are laid and exploded. Details of apparatus, however, are not given, it being stated that these are classed as confidential. It is customary to plant mines in smaller and larger groups, and usually more than one torpedo will be attached to a single cable core, the various cores as they approach the shore being gathered into a multiple cable of several cores. Thus, starting with a cable of ten cores, it is laid by the most direct line from the operating casemate to a convenient point in the rear of the line of mines it is to serve. There, by means of a large junction box, it is connected with ten single-core cables, each leading to one of a line of smaller junction boxes; at the latter each single conductor branches into perhaps three other single-conductor cables, each of which goes to a torpedo. By this arrangement when firing is by judgment, and thus involves some uncertainty as to the actual distance of the hostile vessel from the mines, the defense explodes three charges at once, thereby increasing the probability of an effective blow. If, on the other hand, the hostile vessel strikes a torpedo, only that one will explode, which ought to be sufficient to destroy the vessel. As daily electrical tests of the mine circuits is necessary, there is a continuous circuit through the torpedo, and this is of high resistance, so that even if the firing battery is on it cannot fire the mine. There is also a circuit closer in series with the detonators and in parallel with a high resistance. When the mine is struck, the circuit closer acts, and opens up a circuit of lower resistance through the detonators, which latter may be of the type having a continuous bridge of fine wire surrounded by some fulminating substance.

It is desirable, however, to know when a torpedo is struck, or whether a circuit-closer acts from any other cause, even if the mine is not to be fired. Moreover, it is objectionable to keep cables under such high voltage as is necessary in a firing battery. It therefore becomes desirable to have another battery of very constant e.m.f. always on the circuit, which will cause a tiny current always to flow. When, however, a circuit-breaker acts this current increases to such a point that it will drop a signal showing to which triple group the torpedo belongs, and also closing the circuit of the firing battery through the corresponding cable core. In case the torpedo is fired, the explosion from it may cause the circuit-closers of neighboring mines to act, and thus explode the whole system. To prevent this a device is employed which allows a firing current to flow long enough to explode certainly the mine that is struck, but which will break immediately thereafter, and remain broken long enough for neighboring mines to right themselves. If ground mines are used, in automatic firing the circuit-breaker is carried in a buoy anchored to the ground mine, and having electrical connection with it, the requirement for ground mines thus being the same as for buoyant mines. The paper describes various other general details of mining circuits and apparatus.

Major George W. Goethals, of the United States Army, gave an account of the use of electricity in permanent sea-coast defenses, together with the recommendations recently made by a board of officers on this subject. There are three services to be provided for at any military post, consisting of a search-light service, emplacement service and garrison service. The emplacement service requires current for lights in the various parts of each emplacement, on each main platform and in the range-finding stations; also current to work the motors for amunition service, for manipulating the guns and to operate a machine shop for minor repairs of the guns and carriages; and finally, for a recently adopted telautograph system, connecting the range-finder stations with each other and with their respective batteries. To supply these three services current is generated in a central power station, the minimum capacity of which should be twice the normal demand for search-lights. The plant should be in two equal, wholly independent parts, either or both of which may be subdivided, as local conditions indicate. In addition to the mechanical reserve, there is also an accumulator in reserve for the emplacement and search-light service, which battery is also available for garrison service. The board has suggested for the supply of garrison service the conversion of direct into alternating current, the latter being boosted up by a transformer, and thus distributed, or the employment of a double-current generator.

The navy was represented by four papers, one of which—that by Mr. Walter M. McFarland—we reprint elsewhere in full, and another—by Lieut. Harry A. George, U. S. Navy—will be reprinted in these columns in abstract. Lieut. W. V. N. Powelson read a paper giving the reasons for the changing by the navy of the standard of voltage from 80 to 125. The reason given for the adoption some years ago of 80 as the standard of navy voltage was that this voltage was selected as a compromise between the standard voltage of the day—110 volts—and the voltage necessary for search-lights, or 50 volts. The gist of the reasons given for the adoption of 125 volts as the standard service voltage is that, since this is the commercial voltage, it involves a quicker delivery of parts and supplies, decreased cost and a closer selection. Moreover, it involves a less weight of electrical machinery, and lessens the cost of installation of the distributing system. Calculations in detail are given of the saving in weights and costs. Lieut. Powelson says that while at first sight it might appear that the arc voltage could be raised to approximately the line voltage, this in practice is not permissible, for the reason that it is absolutely essential for good regulation of the lamp that the arc voltage should be considerably below the line voltage. It was decided that in using 125 volts aboard ship it would be less economical to have a low-voltage generator for the arc lights than it is to dissipate in resistance the energy necessary to obtain the voltage required for search-lights. It was finally decided to adopt 123 volts for circuit voltage instead of 125 volts, on the ground that since this voltage is not very largely used in shore plants, the navy will be able to obtain 123-volt lamps more quickly from stock than 125-volt lamps!

Lieut. A. M. Beecher considered the subject of wireless telegraphy in the United States Navy. The paper is largely confined to an account of the theory of wireless telegraphy, and is accompanied by diagrams of wireless telegraph circuits. As to wireless telegraphy in the navy, it is stated that the masts of all ships are now being altered and prepared for the installation of wireless apparatus. This is a work of some magnitude, as it necessitates increasing the height of the masts formerly used from about 120 ft. to about 135 ft. The old height of 120 ft. had been fixed as the maximum which could safely pass under Brooklyn Bridge. In the new arrangement provision is made for lowering the mast for this purpose. The upper portion of the mast, at least 50 ft., is of wood, and is stayed with hemp rigging, or, in the case of rigging coming lower down than 15 ft. from the masthead, it may be of wire set up with hemp lanyards.

Wireless telegraphic masts have also been erected at the Navy Yard, Washington; at the Naval Academy, Annapolis, and are being erected at the Navy Yard, New York, the Naval Station, Key West, and at Dry Tortugas. It is proposed to test thoroughly all the various kinds of wireless telegraphic instruments at these several shore stations and on board naval vessels, and after determining upon the system best adapted to varying service conditions, it will be adopted as the standard for the service, and all naval vessels will be supplied with it.

Lieut. Beecher says it is needless to point out how greatly this new

system of signalling will facilitate fleet manœuvers and operations, particularly in the way of supplying and communicating information gained by scouts, and the greatly enlarged field of action in which a single commander can, at all times, be promptly supplied with all important information, and can at the same time control and distribute his fleet to the best advantage.

An Inspection at Niagara.

On Sunday, June 1, the Niagara Falls Power Company shut down its great power installation and took occasion to make a complete inspection of the tunnel and wheel-pit, also of all the apparatus in use. They also broke away the bulkhead in the tunnel extension between wheel-pit No. 1 and wheel-pit No. 2, so that now both of the great wheel-pits are connected with the tunnel.

In order to effect the total throwing off of the load, it was necessary for the Power Company to notify each of its tenants and consumers of power that the shut-down was about to occur. Ample notice was given, and on Saturday, May 31, only a partial load was carried. The time selected for the total shutdown of the great installation was when there was the least demand for power, both locally and on the transmission line. This was after midnight Saturday, and by 1:30 A. M. every turbine and dynamo of the plant was at a standstill. In order that the wheel-pit might be illumined, power was turned in from the generators of the Canadian Niagara Power Company, located in the station of the Niagar Falls Park & River Railway, on the Canadian side. In Buffalo the trolleys were operated by the steam plant, while the Buffalo General Electric Company also got current from the steam plant of the electric lines. At Niagara, all the big electrochemical plants were closed, and naturally the various companies took occasion to inspect all parts of their installations.

It is fully five or six years since the tunnel was previously inspected, and for all these years the powerful stream from the turbines had been plunging through it to the lower river, it being estimated that 4,600 cubic feet of water go through it every second. The number of persons who went down into the tunnel was between 30 and 50, the majority of them employees of the company, who were to aid the engineering force in making a thorough examination. A few others joined with Edward D. Adams, Vice-President William B. Rankine, Resident Engineer William A. Brackenridge and Clemens Herschel, consulting hydraulic engineer, in entering the tunnel to see just how it had withstood the wear and tear of the waters and time. All were dressed in rubber clothing and boots, and they passed down the old wheel-pit to the connecting tunnel about 1:30 A. M. Sunday. Going through the connecting tunnel they made their way to wheel-pit No. 2, at which point they entered the big tunnel. Thus they were able to inspect the new as well as the old work.

Torches supplied the necessary illumination. About a foot and a half of water flowed along the tunnel bottom, owing to leakage of the gates. From the new wheel-pit to the lower river the tunnel is 7,436½ feet long, over a mile, and it took Vice-President Rankine's party an hour to walk this distance in the water of the tunnel. They moved along slowly in order that they might examine the walls and study features that attracted their attention. At no point was the least break or weakness in the walls found. Every part was in as perfect condition as the day it was pronounced completed. Not a single brick of the 19,000,000 used was out of place or broken, or even worn. The condition was simply perfect, so much so that Mr. Rankine stated that he felt his examination would suffice for all time, as the demonstration of perfect workmanship was satisfactory to him. Engineer Brackenridge and Engineer Herschel, as well as Mr. Adams, were also delighted with the perfect condition in which they found the tunnel and pit.

When the party reached the portal of the tunnel they found Engineer R. S. Buck and Superintendent Rothery, of the International Traction Company, already at work inspecting the north American abutment of the upper steel arch bridge. This abutment stands very close to the stream that pours with such fury out of the tunnel, but despite this it was found to be in perfect order and wholly satisfactory. The trip back up the tunnel against the flowing water was slightly more difficult than going down stream. The engineering parties that entered the tunnel devoted several hours in making a complete inspection of all parts of the main tunnel, the paper mill lateral and the pit, and everywhere the work was found in perfect order. At 7 o'clock Sunday morning water was once more turned onto the turbines in wheel-pit No. 1, and the flow of watter from them will rush through the tunnel a great many years before there will again be a total shutdown. Power from the new pit will be delivered in August next, it is expected.

Another Large Generating Station for Chicago.

Public announcement was made last week of what has been rumored about quietly in the engineering field for some months past, namely, that the Commonwealth Electric Company, of Chicago, plans the erection of a large generating station which will rival the Waterside Station in New York in capacity when finally completed. Approximately, 14 acres of land have been purchased on the south branch of the Chicago River, near Centre Avenue, or, to be more exact, at Fisk Street. The property purchased is about a quarter of a mile south of Twenty-second Street on the north side of the river. A small strip has also been purchased on the south side of the river for coal storage. The main property is bounded on the south by the Chicago River, and on the east and west by slips or canals, so that it has water frontage on three sides. Railroad sidings enter both pieces of land.

The location is two miles south and a mile and a half west of what is commonly considered the business center of the city. It is not adjacent to any important part of the company's load, but was selected mainly on account of its suitability for a large power plant with economical supply of fuel and condensing water, and the reasonable price of the land which averaged $54.80 per square foot. The cost of the tract, including the price paid to vacate certain streets, was $353,300.

Although the station is to be built by the Commonwealth Electric Company, a large part of the power will be taken by the down-town district through the Chicago Edison Company. Indeed, it is notable that it is the present intention to make the entire output of the plant 25-cycle, 9,000-volt, three-phase currents, the standard of the two companies for transmission to rotary converter sub-stations and conversion into direct current.

The growth of the plant will be according to demands, but it is expected to spend $1,000,000 a year at least until the investment reaches $6,000,000 and the capacity reaches 75,000 kw. The equipment has not been officially announced, but some revolutionizing changes from former central station practice as regards large units of a new type are expected. A contract for boilers of 6,000-hp capacity has been awarded to the Babcock & Wilcox Company, including superheaters and stokers. It has been reported in the press that Curtis vertical steam turbines will be used, this part of the steam plant to be furnished by the General Electric Company.

This will be the first large electric generating plant in Chicago to be built for exclusively polyphase transmission. The large railway plants of Chicago were built just before polyphase current power distribution for large cities became established. The Harrison Street main generating station of the Chicago Edison Company was originally started as a purely direct-current station, but in the last few years several double-current generators have been put in, adapted to either purpose.

In this connection it is interesting to note that it is just about an even ten years since the Harrison Street Station was planned, and at that time it was considered a monster, the capacity of which would not be soon reached. The capacity afforded by the new plant will enable the Washington Street Station ultimately to be shut down, and will provide for the growth of the Edison and Commonwealth systems for many years.

The new station, together with the power soon to be received by a 33,000-volt transmission from the water-power plant of the Economy Light and Power Company, of Joliet, next fall, will make an important revolution in the power generation of the two allied central station companies which cover the Chicago field. This Joliet power will, as noted in a previous issue, operate centrifugal pumps for supplying the Illinois and Michigan canal at Bridgeport in Chicago, and power will also be supplied to the Commonwealth Electric Company in sufficient quantities so that it can shut down its Fifty-sixth Street Station during the day.

Boston Meeting of American Society of Mechanical Engineers.

The programme of the meeting of the American Society of Mechanical Engineers, held at Boston, May 27 to 30, included 22 papers, of which several dealt with electrical subjects.

Messrs. I. E. Moultrop and R. E. Curtis read a paper entitled, "Recent Construction at the Atlantic Avenue Station of the Edison Electric Illuminating Company, of Boston." This plant was elaborately described in these columns about a year ago, and the authors of the paper referred members to this description for a fuller account of the plant.

Mr. Wm. H. Bryan, of St. Louis, in a paper entitled, "Some Details of Direct-Connected Generator Sets," gave the results of a recent investigation into some details of design and construction of steam-driven, direct-connected generators. Correspondence was conducted with a number of leading engine and generator builders, and supplemented with personal interviews. Mr. Bryan found that there seemed to be a practically unamimous agreement to follow the general design and dimensions recommended by the Society's committee on Standardization of Engines and Dynamos in its final report of December, 1901. The paper deals principally with relations between the dynamo designer and the engine builder, and gives information as to what drawings and data should be furnished the latter. Mr. Bryan considers that the overload limit of 25 per cent. recommended by the committee might be increased to 50 per cent., since most generator builders now guarantee their standard machines for that amount of overload. There appeared yet to be a difference of opinion as to whether it is preferable to mount the armature on conical collars instead of the usual press fit. Mr. Bryan considers that the engine shaft carrying the armature should be continuous, and was surprised to find a large and growing sentiment among builders of center-crank engines in favor of the coupled shaft.

Mr. Geo. H. Barrus gave an account of tests recently made, of steam-pipe coverings, of which 17 different kinds were submitted for test. Full details were given of the method of tests and the manner in which the final results were calculated. Tables are included, giving in detail the dimensions of the pipes upon which the coverings were tested, data regarding the covering, and cost of the same. With 2-in. pipes and 150 lbs. pressure, the thermal units lost per deg., per sq. ft., per hour, with bare pipe, were 3.366, while the loss with different kinds of covering varied from .462 to .606 unit. The loss with 2-in. bare pipes under 80 lbs. pressure was 3.081 thermal units, and with the several kinds of covering tested, the corresponding loss varied from .728 to .793 thermal unit.

The subject of "Liquid Fuel Combustion" was considered in a paper presented by Mr. Chas. E. Lucke. The principles of fuel combustion were outlined, and an account given of experiments with various types of vaporizers and burners. The object of the paper was to point out the merits of a particular method of burning fuel oil.

Mr. R. A. Fernald described a method of determining the temperature of the exhaust from gas engines. A receiver is placed close to the exhaust port of the engine through which the gas is emitted, and the pressure allowed to fall to that of the atmosphere, when the desired temperature is ascertained. Mr. Fernald also presented a paper on the working details of a gas engine test, in which all the methods of such a test are outlined and the method of calculating the data given.

Perhaps the most valuable contribution presented was the final report of a committee appointed in June, 1898, to codify and standardize the methods of making engine tests, the results of its work being given in the above-mentioned report. The whole subject of engine and steam plant testing is systematized, and 23 rules are given for conducting such tests. The rules deal with the following subjects: Object of test; general condition of the plant; dimensions, etc.; coal; calibration of instruments; leakage of steam, water, etc.; duration test; starting and stopping test; measurement of heat units consumed by the engine; measurement of feed water or steam consumption of engine, etc.; measurement of steam used by auxiliaries; coal measurement; indicated horse-power; testing indicator springs; brake horse-power; quality of steam; speed; recording the data; uniformity of conditions; analysis of indicator diagrams; standards of economy and efficiency; miscellaneous; report of tests. Five tables are given, consisting of forms for recording the data and results of steam-engine tests. The rule on the analysis of indicator diagrams is particularly valuable, being accompanied by forms of cards illustrating all the various points considered. The analysis of diagrams is considered under the following heads: Steam accounted for by indicator; heat analysis; sample indicator diagrams; the point of cut-off; ratio of expansion; diagram factors and total losses. An appendix to the report gives a code of rules for conducting tests of gas and oil engines.

Power Transmission to Montreal, Canada.

With regard to our recent article on the power development at Shawinigan Falls, and Mr. Wallace C. Johnson's work there as hydraulic engineer, that gentleman has kindly favored us with the following data as to the contract between the Shawinigan Water & Power Co. and the Lachine Rapids Hydraulic & Land Co.:

The generators at Shawinigan are two-phase, 30-cycle, 2200-volt machines of a capacity of 3,750 kw. This frequency of 30 cycles was adopted because at that time I thought we should enter Montreal as an independent company, and in view of the local distribution at Shawinigan and the long transmission line I adopted 30 cycles as the best frequency. By this contract with the Lachine Co., however, we are obliged to deliver to them current at a frequency of 60 cycles, as they already are using 60-cycle current in distribution. It therefore becomes necessary either to install 60-cycle generators at Shawinigan Falls or to install frequency-changers at the Montreal end of the line. As we have undertaken to deliver power by the first of January, it is impossible to install additional water wheels and generators at Shawinigan Falls in time, and it becomes necessary to transmit 30 cycles and put in frequency-changers or motor-generators in the terminal station at the Montreal city line. We have adopted as a unit of transmission 4,000 hp delivered, and we are installing the first one, to deliver current at 30 cycles, 40,000 volts and step down to 2,300 volts, installing frequency-changers or motor-generators to transform to 60 cycles.

The line will run along one or the other of the two railroads connecting Shawinigan Falls with Montreal, namely, the Great Northern or the Canadian Pacific. It is likely that the route along the Canadian Pacific will be chosen on account of the several towns along the line at which power could be delivered. The distance by either route is about 85 miles.

An order has already been placed with the Pittsburg Reduction Company for aluminum cables for the transmission line. These cables will consist of seven strands of No. 6 wire, and will be manufactured from the ore at Shawinigan Falls, where the Pittsburg Company has works.

Rating of Incandescent Lamps.

At the Cincinnati convention of the National Electric Light Association, the Committee on the Rating of Incandescent Lamps, consisting of Messrs. Louis Bell, Jas. I. Ayer and Calvin W. Rice, reported that while preliminary arrangements had been made to have the work of standardizing incandescent lamps done at Columbia University, it soon became evident that under the able and energetic administration of Director Stratton, the National Bureau of Standards would actually be able to provide certified incandescent lamps, which, moreover, would carry greater weight as standards that an unofficial institution could hope to give, within a reasonably short time. It therefore seemed best to avoid the expenditure that would have been necessary to prosecute the work in behalf of the institution, and inasmuch as the Bureau of Standards is now substantially ready to take up the work of supplying lamps, the Committee recommended that the Association shall adopt the certified standards of the United States Bureau of Standards as the basis of rating for incandescent lamps.

With respect to the manner in which incandescent lamps shall be tested, the Committee adhered to the opinion, that while in theory the mean spherical candle power should be the final test for luminous radiation of incandescent lamps or other lamps until such candle power can be determined by more correct and precise processes than are now commercially available, it is best to depend upon the mean horizontal candle power, to be determined by rotating the lamp in the manner heretofore suggested and in general use. Obviously such a measurement does not place lamps with all possible shapes of filament on a parity, but it does treat with substantial justice ordinary commercial incandescent lamps; and

moreover it corresponds to the way in which other illuminants—competitors of the electric lamp—are habitually measured.

Cases will undoubtedly arise in which candle power in some specified direction may demand the consideration of the members of the Association. In all cases where directed candle power—as contra-distinguished from distributed candle power—is to be considered, the only possible way of placing various illuminants on a parity is to measure their intensity in the direction in which a specialized radiation is wanted, including in such measurement the effect of all devices intended to produce directed illumination, such as reflectors, special globes and special positioning of the light-giving parts of the lamp with reference to intensity in particular directions. The great bulk of all lighting done by members of the Association is distributed lighting, and for this purpose the Committee believes that the mean horizontal candle power rating should be adhered to; while for the special problems of directed lighting all means for securing unusual intensity of illumination in some particular direction of the lamp ought to be included and placed on a parity.

For example, rating a Nernst lamp—which is deliberately intended to give a downward hemispherical distribution—on its mean horizontal candle power would be manifestly unfair; while if a lower hemispherical distribution is for any particular purpose desired, it would be equally unfair to deny to incandescent lamps the privileges of using reflectors or similar means of turning downward the luminous energy, which would otherwise not be radiated in the direction contemplated. In other words, the Committee considered that a logical distinction can be drawn and should be made between general and directed illumination. Lights designed for the former class of work can be conveniently measured in a single conventional zone, while in directed illumination the only fair programme is to compare lights on the basis of the directed beam which is desired for practical use.

Electric Furnaces—Separation of Metals.

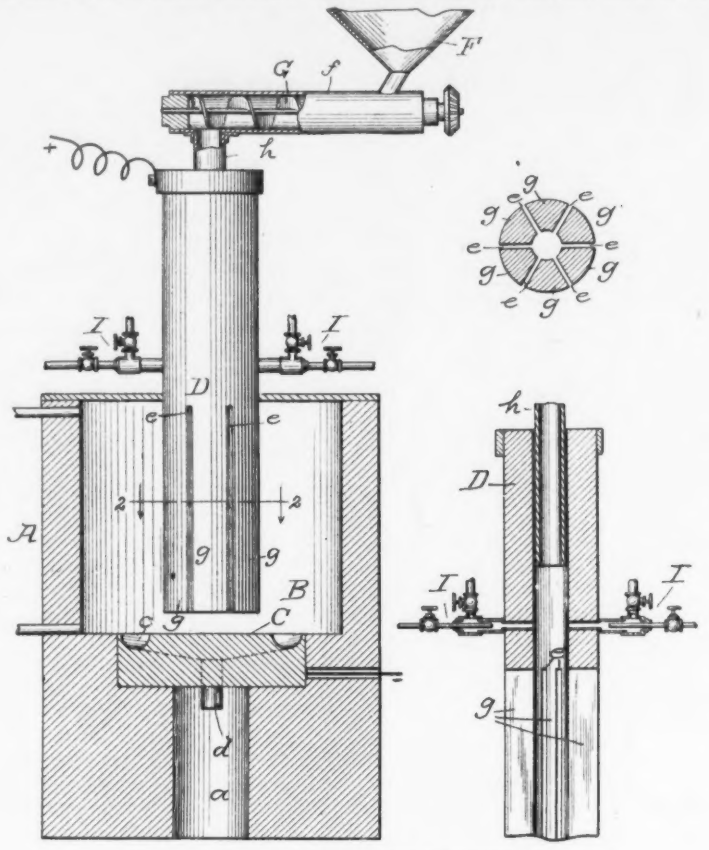
BY CLINTON PAUL TOWNSEND.

IN electric furnaces, the bar which supports the pendant electrode usually serves also to transmit the current. For furnaces of moderate size this is simple and convenient, but for the heavy currents of the present installations it is at least open to question whether two functions are properly performed by a single element; the size of the support is governed by its strength, that of the lead by its conductivity, and both support and lead are limited in size by their capacity for conveying heat from the furnace. A system of connections patented by Fausto Morani, of Rome, Italy, employs a conductor and a separate supporting yoke, each of the minimum size to permit a proper performance of its function, and each provided with a circulating system for water. Other features of the furnace are a vertical discharge slit between water-cooled walls and a water-cooled fore-hearth—both mere adaptations from ordinary metallurgical practice.

William P. Parks, of Chicago, patents the carbide furnace herewith illustrated. The lower carbon electrode *C* is embedded in the hearth of the covered furnace *A;* the upper surface of this electrode is flush with the furnace base and is channeled to provide an annular gutter *c* for the molten carbide, which is drawn off through a tap *d* in the body of the electrode into the tunnel *a*. The upper electrode, shown also in horizontal and vertical section in Figs. 2, 3, is a tubular carbon *D* divided as at *e* along radial lines to form separate terminals, *g*, and to insure, so far as may be, a plurality of separate arcs at the working terminal. This electrode serves also as a feeding conduit for the charge, the latter being introduced into the hopper *F* and transferred by the conveyor *G* in the casing *f* to the charging tube *h*. Hydrocarbon burners *I*, mounted in the sides of the electrode *D*, serve for preliminary heating the descending charge.

SEPARATION OF METALS.

Dr. Nathaniel Shepard Keith described, at the inaugural meeting of the American Electrochemical Society, a striking method for the treatment of metallic solutions with insoluble anodes. In work of this character the concentration of the cations constantly decreases, and in order to secure a uniform reguline deposit the current density must be correspondingly reduced. This is usually accomplished by controlling the current through the vat—an obviously uneconomical expedient, since the capacity of the generator is fully utilized only in the early stages of the operation. Dr. Keith's solution, as indicated herewith, consists in circulating the electrolyte through a number of vats in series, indicated from G^1 to G^7 in Fig. 4, the electrodes therein being connected in multiple and the number of plates increasing in successive members of the series. As the same current passes through each vat, it is clear that the electrolyte



FIGS. 1 TO 3.—PARKS ELECTRIC FURNACE.

is subjected to a current of diminishing density, and that if the strength of the incoming electrolyte be maintained constant and the numbers of electrodes in successive vats properly proportioned, a regular deposit may be obtained throughout the series and the full capacity of the generator utilized.

Dr. Ludwig Mond, of London, whose name is chiefly associated with the "Carbonyl" method of extracting nickel, patented abroad some years ago a method for the electro-deposition of zinc from alkaline solutions upon rotating cathodes of iron, the distinctive feature being the employment of sodium amalgam, produced according to the electrolytic method, as the anode. In other words, the inventive conception was the electro-deposition of zinc instead of the decomposition of water in the oxidizing compartment of a Castner cell.

Zinc so deposited is spongy, and in two recent patents Dr. Mond returns to the old expedient of compressing the deposit as formed.

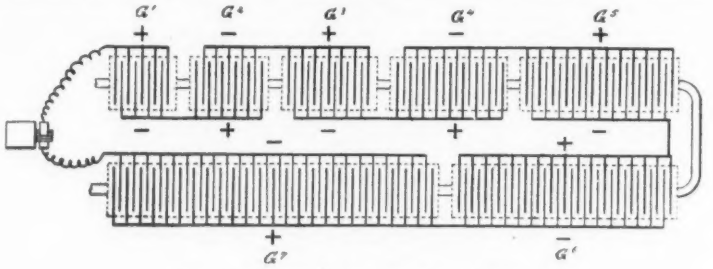
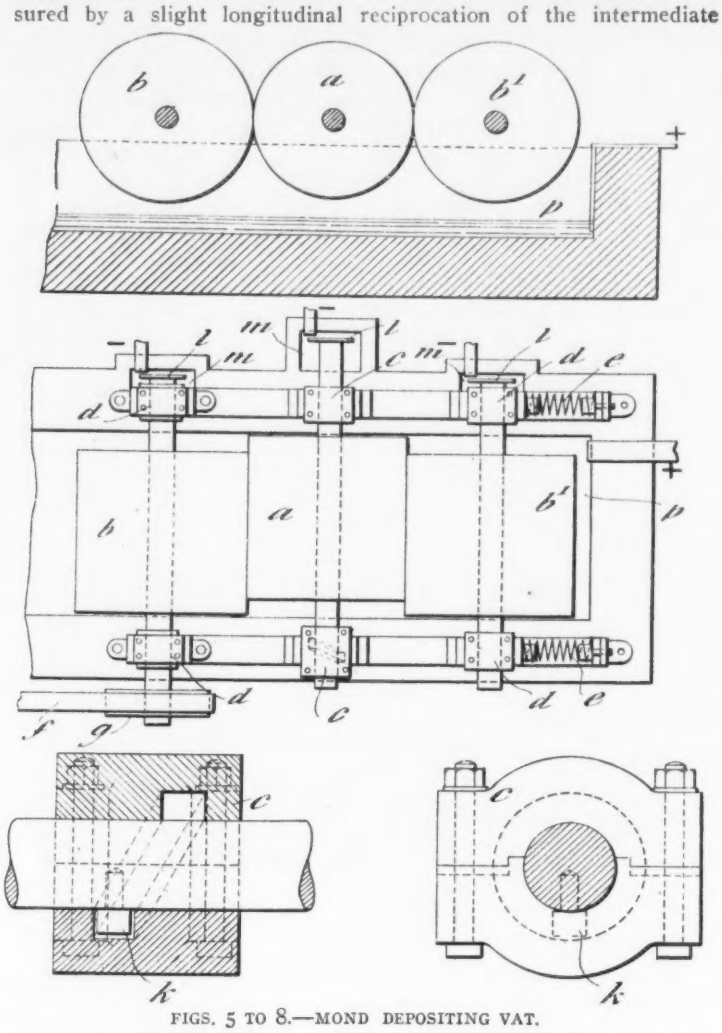


FIG. 4.—KEITH'S ELECTROLYTIC VAT.

This is effected by the arrangement shown in vertical section in Fig. 5 and in plan in Fig. 6; a series of cathodes, *b*, *a*, b^1, are rotatably mounted above the amalgam anode *p*, and driven by a belt *f* and pulley *g*, upon the axle of a member of the series. The several cylinders are mounted in sliding bearings *c*, *d*, and held in proper contact by springs *e*. Cathode connection is made through discs *l* revolving in mercury cups *m*. The cathode cylinders may be vertically or horizontally mounted, and either superposed or hori-

zontally aligned as shown. The cylinders *a*, b^1 are revolved by frictional contact with the driven cylinder *a*, and to insure an even compression of the deposit the intermediate cathode *a* is of slightly reduced diameter, the effect being to bring different portions of the deposit into contact in successive revolutions. This is further assured by a slight longitudinal reciprocation of the intermediate



FIGS. 5 TO 8.—MOND DEPOSITING VAT.

cylinder, imparted by the cam-groove *c* and roller *k*, shown in detail in Figs. 7, 8.

Francois Urruty, in 1895, described a somewhat similar disposition of large and small cathode cylinders for compacting electro-deposited copper; in accordance with this prior art all of the claims of the present patents are limited to both longitudinal and transverse rubbing of the electro-deposit.

New Telephone Patents.

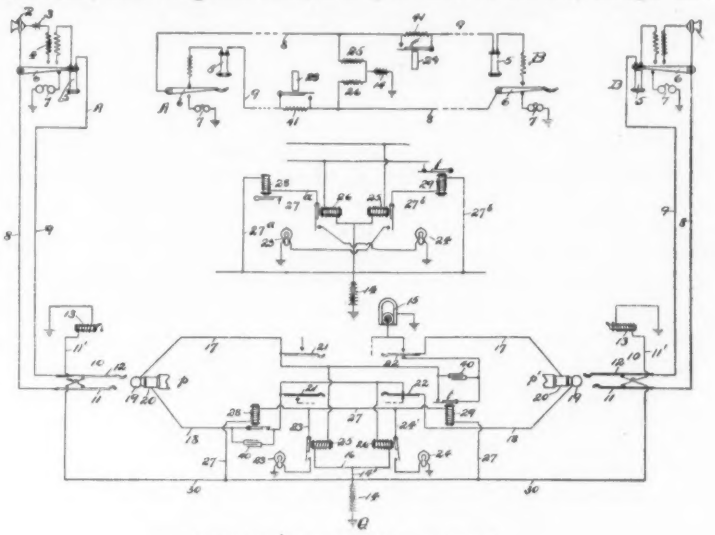
The issue of the Patent Office of May 27 contributes directly to the telephonic art but two patents, and one of those is of that numerous class which appears to have little prospect of success. This particular invention is entitled a "signalling and telephoning apparatus," and the drawings show a wall telephone set equipped with a reel, on which is wound a flexible cord terminating in a plug for the object of connecting the instrument to a rod (made in sections with bayonet joints), by means of which the instrument may be connected to the line wire to be tapped. The generator is designed to give a pulsating or intermittent current, so that a special signal may be sent. Just where the novelty of the invention lies is beyond the reviewer's power to discover.

The second patent is due to Mr. Henry P. Clausen, of Chicago, assigner to the American Electric Telephone Company, and covers a telephone system with common battery signalling, but local battery transmission, in which the principal novelty is the placing of the supervisory relays in bridge and the provision of auxiliary relays which open the cord circuit to prevent the operation of the second supervisory signal when the condition of the connection requires that only the first shall be shown. Mr. Clausen claims for his system that it provides a complete supervisory system of signals for established connections, as well as means for automatic signalling of the exchange by sub-stations, and, in general, is efficient and economical. A grounded signalling bell is provided at the sub-stations, which may be a low-wound bell, and therefore cheap.

Referring to the diagrams, *A* and *B* represent sub-stations equipped with grounded bells and local battery transmitters. The battery at station *B* is omitted, evidently by a draughtsman's error. On taking the receiver off the hook the common signalling battery 14 is grounded through the line signal 13 by way of wire 30, line 9, the sub-station circuit, line wire 8 and spring 11 of the answering jack. When the plug is inserted in the answering jack the line signal is disconnected, as shown. The usual listening and ringing keys are shown conventionally at 21 and 22, the circuits not being shown in full; 22 puts the grounded generator to line 8 to signal the sub-station. The supervisory signals 23 and 24, preferably lamps, are controlled by relays 25 and 26, connected in the bridge 16 across the cord circuit, the bridge being connected to common battery 14 by the wire 14′. The supervisory lamp circuits are extended through the front contacts and armatures of relays, 25 and 26, by conductors 23′ and 24′ to a common conductor, 27, that includes the relays 28 and 29 and connects with the common battery lead 30; these relays 28 and 29 serve by their armatures and back contacts to open the cord strands 17 and 18 at the points indicated.

In the operation of the system, assuming *A* to be the calling station and *B* the called, when the plug *p*′ is inserted in the jack the relay 26 is energized, a path for the grounded battery being made by wires 14′, 16, relay 26, cord strand 18, line 8 and to ground through the bell at *B*. The lamp 24 is then lighted. The lamp circuit, 30, 27, 24′, also includes in its parallel paths the relays 28 and 29, which are then energized, and open the cord strands 17 and 18 at the points shown, the said strands including the armatures and resting contacts of said relays in the end portions over which the relays 25 and 26 are not operated. The function for so opening the cord strands on the other side of the bridge 16 from that over which the said relays are operated is to prevent the operation of the other relay—in this case 25—over the cord strand 17, line wire 8 to station *A* and back over conductor 9, strand 18 to ground at *B*, which would light lamp 23, to the confusion of the operator; the opening of strand 18 by relay 28 prevents this undesired operation of 23, but leaves intact strand 17 from bridge 16 to plug *p*, over which by line wire 8 relay 25 may be operated when *A* places the receiver on the hook. This circuit is illustrated more simply in Fig. 2, where *A* is shown with the hook up and *B* with it down.

In one of the figures the auxiliary relays are shown in separate branches, an arrangement which may be used if desired, though that



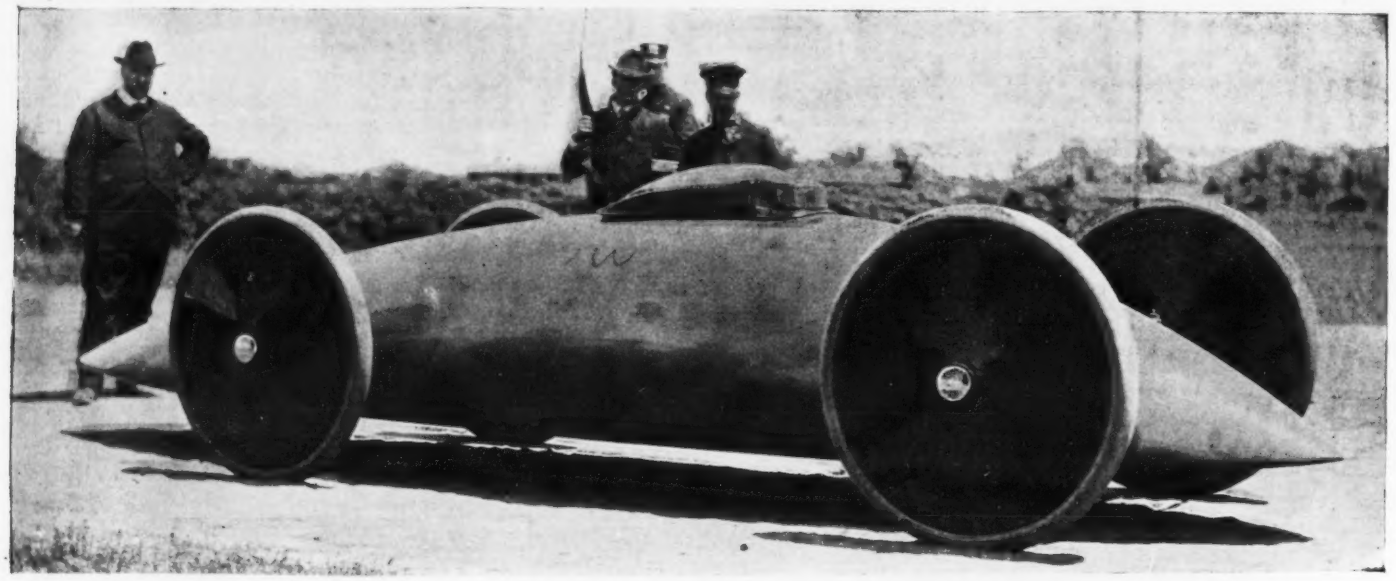
CLAUSEN'S TELEPHONE SYSTEM.

shown in the principal figure is preferred. The break in the cord circuit produced by the action of relays 28 or 29 is bridged for talking purposes by condensers 40, as shown in one figure; or, if preferred, high resistances may be used, as shown at 41 in another. Mr. Clausen has worked out his system with considerable ingenuity, but two points strike one from the practical point of view; one is that a system employing common-battery signalling and local battery talking is a trifle out of date, and the other is that the auxiliary relays merely provide a remedy, at the price of additional complication of apparatus and circuits, for the defect inherent to the system, of operating both supervisory signals when only one is required.

Fatal Accident with a High-speed Electric Automobile.

Under the auspices of the Automobile Club of America, a series of speed contests with automobiles were given on Saturday, May 31, on the Southern Boulevard, Staten Island. A finer day could not have been wished, and the attendance was very large, both of automobilists and of the public, but the sports were brought to an untimely close by the "going wild" of an electric automobile, which broke from the track, and plunging into the serried ranks of the crowd near the finish line, killed two persons and wounded seriously several others. It had been rumored that an attempt was to be made to lower records, not only for steam and gasoline, but for electricity, and a great many electric people had gathered, among them being Thos. A. Edison, W. S. Mallory, F. C. Phillips, J. C. Reilly, T. C. Martin, H. Ward Leonard, F. Ott, J. M. Hill, etc., most of these being congregated at the club headquarters at the Boulevard Hotel, while Mr. Hill was the official starter, Mr. Bee was timer, and Mr. Leonard had two or three of his gasoline vehicles competing on the track.

For a few days previous to the contests, Mr. W. C. Baker, of the Baker Motor Vehicle Company, of Cleveland, had had in storage at one of the trolley company's car barns along the route leading to Midland Beach a vehicle with which he hoped to eclipse all vehicle speed records of any kind whatsoever; and the batteries were charged at this point, about a quarter of a mile from the Southern Boulevard paralleling the high road. The thousands of people present had learned of the presence of this vehicle and had heard that in Cleveland it had made speed at rates up to 80 or 90 miles an hour; hence the great curiosity to see it.



HIGH SPEED ELECTRIC AUTOMOBILE.

The machine, which is here illustrated from an excellent photograph secured on the track by the "New York Tribune," was designed by Mr. Baker for a minimum of wind resistance, and was built broadly on the lines of the Serpollet machines of the steam type, which hold the world's record of a kilometer in 29 4-5 seconds. It weighed about 3,000 pounds, and the shell housed two chauffeurs as well as the steering gear and switches, etc., besides hiding completely the motor and batteries. While everything was as light as possible, it was not thought by Mr. Baker that any undue concession of needed strength had been made; but the accident disclosed the fact that the wheels under their cheeks of oiled silk had only wooden rims and wire spokes. The motor built by the Elwell-Parker Company, of Cleveland, for the machine, was of 7 hp, capable of developing easily up to 12, and the 40 cells of battery had been furnished by the Gould Storage Battery Company. The tires were 3½-inch Palmer. The equipment, in fact, had been well tested as to its constituent parts, and the popularity of the Baker automobiles has been due to it; while Mr. Edison himself has been trying the "low-volt" Baker vehicles in his own automobile battery experiments. The wheels above referred to were about 36 inches in diameter and about 6 feet apart, while the light hood, some 15 or 18 feet long, like half a cigar or half a torpedo, extended the full length, the nose and tail protruding. At the centre was a small conning tower for the drivers, windowed with mica, and provided with straps. As the shell was covered with black shiny canvas, or oil cloth, its appearance justified the name that had already been popularly applied to it of "demon" and "freak." It cleared the ground barely five or six inches, and its movement had somewhat of a similarity to flight.

Between 12 and 1 the sport was in full swing, and the crowd near the finish had become so dense on both sides of the track as to push away the police. One side was roped in, but the other, on the left, was open; and there the people massed just beyond the Midland Beach trolley car tracks. The vehicle, with Mr. Baker and his chauffeur, Denzer, got away safely from the starting-post, and Mr. Baker states that they were making a speed of about 75 miles an hour as they came abreast of the Boulevard Hotel. It is even alleged that there the speed was "hit up," and that the automobile began to wobble on the curved roadbed. Be this as it may, when she struck the raised car tracks and went up in the air something was wrong with one of the wheels when she fell to the ground again; and, moreover, she had swerved. Like a flash she swung away to the left and bored a bloody path into the shrieking crowd, dealing death and terror even before anyone could realize what had occurred. Fortunately there were an ambulance tent and doctors near by, and fortunately also the riders, who even in the excitement had set the brakes, were extricated from the wreck with but few injuries. The sports ceased immediately, and Messrs. Baker and Denzer were put under arrest, although on Monday they were acquitted by the coroner's jury. A cursory examination of the automobile would lead one to infer that very little injury had been sustained by its mechanism. But whether she ever takes part again or not in speed contests it is certain that they will not be under the supervision of the Automobile Club of America on public roads. President Shattuck and other conservative officers have always been opposed to road racing, and this tragic incident settles the matter.

Honors for Prof. Bovey.

Prof. H. T. Bovey, LL.D., Dean of the Faculty of Applied Science of McGill University, Montreal, has, we are glad to note, been elected a Fellow of the Royal Society, in recognition of his admirable work in applied science, civil engineering, etc. His papers cover a wide range of topics, embracing much original research of a high order. Prof. Bovey, in addition to his membership in other societies, is an honorary member of the National Electric Light Association, and has a host of friends in scientific, educational and electrical circles in the United States, all of whom will learn with pleasure of this latest, well-deserved honor. His splendid success in building up the endowments of science at McGill, giving it a foremost place on the American continent, has already been described in our pages.

CURRENT NEWS AND NOTES.

SHAWINIGAN TRANSMISSION PLANT.—The Shawinigan Water & Power Company will shortly construct a 50,000-volt transmission to Montreal, about 90 miles from the generating station. Mr. Ralph D. Mershon will act as consulting engineer for the transmission plant. The plans involve transmitting 20,000 hp to Montreal, beginning with 4,000 hp, to which additions will subsequently be made in 4,000-hp units.

NEW TYPE OF COHERER.—A patent issued May 20 to Harry Shoemaker, Philadelphia, describes a coherer in which small steel balls are employed in connection with granulated particles of carbon. The small steel balls are so placed in the coherer tube as not to be in contact with each other, and are surrounded by the carbon particles. The specifications state that by the employment of the carbon particles and the steel balls, no decohering is necessary, as carbon and steel contacts have a property of destroying themselves without the use of a tapping or shaking device.

TESLA PATENT LITIGATION.—Judge Lacombe, in the United States Circuit Court, New York City, on June 4, denied the application of the Westinghouse Electric and Manufacturing Company for an injunction to prevent the Stanley Electric Company from manufacturing apparatus claimed to come under certain Tesla patents. The refusal was made on the ground that the Stanley company manufactured the appliances in Pittsfield, Mass., and that, therefore, the matter was not within Judge Lacombe's jurisdiction. The question of the alleged infringement of the patents was not considered. The case was argued last week, the defendants being represented by ex-Speaker T. B. Reed, ex-Patent Commissioner Mitchell, and Mr. W. H. Kenyon.

A CORRECTION.—On account of a misplaced word in the article by Mr. F. G. Baum on "Synchronous Reactance," in the issue of April 26, the method given for measuring the synchronous reactance is apt to be misinterpreted. The beginning of the eighth paragraph should have read as follows: "Run the generator as a synchronous motor, but with no load. Set the excitation for normal working value. Now raise the *voltage* applied to the motor until one-half the full load current flows in the motor." In place of the italicized word "voltage" in the last sentence, the word "excitation" appeared in the article. By setting the excitation of the motor for different values of induced pressure, and then raising the voltage applied until full load current is forced through the motor, the synchronous reactance may be obtained corresponding to any degree of magnetization of the generator.

ARC LAMP CARBIDE ELECTRODES.—A patent granted May 20 to Robert Hopfelt, of Berlin, Germany, describes several forms of a new type of electrode for arc lamps. In each case the material of the electrode consists of calcic carbide, coated with a water-proof compound or sheathed with a metal such as aluminum. It is stated that metallic carbides, such as calcium carbide, gives a much more powerful arc than do ordinary carbon electrodes, but that this material has not been employed in arc lighting heretofore because of decomposition incident to the presence of moisture in the air. By covering the surface of the carbide with a layer impervious to moisture, it is claimed that this objection is obviated. In another form of the electrode there is a core of metallic wire, and in still another form, a core of carbon dust. A solid electrode is also described, consisting of a mixture of carbon and carbide.

RELATIVE HEATING EFFECT OF ALTERNATING AND DIRECT CURRENT UPON LEAD-COVERED CABLES.—In reply to a question, at the recent Electric Light Convention, as to the relative heating effect of alternating and direct current upon lead-covered cable, Mr. Calvin W. Rice said: There is relatively no difference. If a simple rule be followed there will be no heating whatever—namely, the outgoing and returning cables of all alternating circuits should be inclosed in the same sheath. For instance, a single-phase alternating circuit should have a twin cable inclosed in one lead cover. A two-phase circuit can be considered as made up of two single phases, or if operated on the three-wire system, then all three wires should be within the same lead cover; likewise, the three-phase circuits should be in a three-conductor lead-covered cable. With direct current there is absolutely no heating in the lead or iron-pipe conduit. With the outgoing or incoming wires of any alternating circuit assembled in the same sheath, there will be absolutely no heating. Therefore, there is no heating effect of either alternating or direct current when installed as above explained.

SINGLE-PHASE RAILWAY MOTOR.—Among the patents of May 20 is one issued to the estate of Rudolf Eickemeyer, the application for which was filed August 10, 1893. The motor described is intended more particularly for railway service, and several of the 35 figures accompanying the specifications shows it applied to a railway car, the motion of the armature being transmitted to the wheels by means of connecting rods. The motor is very complicated in both its magnetic and electrical elements. Briefly, it consists of a four-pole commutator alternating-current motor, every other bar of the commutator being "dead." On the field, the magnetic portion of which is of complicated shape, there are three separate coils, one of which is denominated a field coil, another a counter-field coil, and the third an isolated or counter-balancing coil. The armature reaction is neutralized by the counter field coils; the counter-balancing coils are of higher resistance, their function being to counterbalance the e. m. f. induced in the armature coil or coils which are just passing under the brushes. The current passes through these coils in different order according as the brushes are on live or dead bars. The speed and direction of rotation of the motor are varied by shifting the brushes. It is stated that a motor thus constructed will work with almost equal efficiency at any desired speed.

NEW TYPE OF LIGHTNING ARRESTER.—A lightning arrester is described in a patent issued May 27 to Giovanni Gola, of Genoa, Italy, which is stated to be based on the following principles: First, the tendency of static electricity and high-frequency alternating currents to avoid the central portion of conductors and accumulate for the greater part on superficial portions (skin effect); second, the tendency of the electric lines of force acted upon by a magnetic field perpendicular thereto, to be displaced in a direction perpendicular to their own, as well as to the direction of the magnetic lines of force; third, the difficulty met with by atmospheric discharges on their path from conductors of large surface to ones of small surface and small cross-section, especially when the direction is to be abruptly changed. The apparatus illustrated consists of a hollow body, the outer surface and the cross-section of which are by far larger than the cross-section and outer surface of the conductor to be discharged. This body has preferably the form of a solid of revolution and is made of a magnetic material coated with a layer of non-magnetic material, the latter being of zinc. The lightning arrester is placed in series with the line to be protected. The outer surface is connected with the part of the overhead wires subjected to atmospheric discharges, and its inward surface with the part of the conductor which the apparatus is intended to protect.

MOTOR COMPENSATOR.—A patent was issued May 27 to C. P. Steinmetz on an application filed Aug. 16, 1897, on an alternating-current motor compensator, the object of which is to reduce the starting torque of a synchronous or induction motor only in proportion to the reduction of current taken from the mains, the torque per ampere of the main current remaining unchanged. After the motor is started the regulator can be adjusted so as to raise the voltage at the motor terminals until full voltage is reached. The regulator comprises a magnetic structure consisting of a fixed and a movable part, provided with compensator coils, one for each phase when used on a polyphase circuit. The compensator coils are connected across the mains, and the motor or other regulated circuit is connected to corresponding intermediatte points in these coils. The coils have a series branch or portion in series with the load, and a shunt branch or portion in parallel with the load. One form illustrated for use in connection with a three-phase motor consists of a 6-pole ring, every alternate pole having coils. Within the ring is a movable magnetic iron shuttle with three poles. By changing the relative positions of the poles of the shuttle, the magnetic circuit can be varied so as to include both the series and shunt branches of the compensator-coils in a closed magnetic circuit, and therefore in a position to transfer energy from one branch to the other; or to withdraw the series shunt branches from inductive relation by opening the circuit of the series branches and leaving the magnetic circuit with the shunt branches closed.

BRAUN WIRELESS TELEGRAPH PATENTS IN GERMANY.—A cable dispatch from Berlin states that on May 30 a court handed down a decision sustaining the Braun claims in an action brought by the Allegemeine Elektricitats Gesellschaft, owner of the Slaby-Arco system, against Siemens & Halske, which represented the Braun system. The dispatch adds that the case may be brought before the Supreme Court of the empire for final adjudication.

TRANSFORMER BREAKDOWN TESTS.—In the article by Mr. R. F. Schuchardt on page 855 of ELECTRICAL WORLD AND ENGINEER of May 17, 1902, a printer's error in figures in regard to the proper voltage to be applied to the primary of a transformer made Mr. Schuchardt say that for a transformer with 2,000-volt primary the voltage applied between the primary and secondary and between primary and core is generally not less than 2,000 volts. This should read, "for a 2,000-volt primary transformer this voltage is generally not less than 8,000 volts between primary and secondary and between primary and core."

DEVELOPMENT AT THE SOO.—Note was made recently in these columns of a large contract for Stanley generators at the Soo. A special dispatch from Sault Ste. Marie of May 26 says: Another great water-power canal is to be dug by the Clergue Syndicate here. It will be the third to use the water of Lake Superior for the Consolidated Lake Superior Company, and will increase the company's power to about 110,000 hp. The canal will require the removal of 400,000 cubic yards of earth and 600,000 yards of stone, and will be several years in building. This canal will provide power for a great metallurgical plant to treat ores of copper, zinc, silver and gold electrically. The ores for treatment are expected to come from Western Canada and from the region to the north of the Sault, where extensive developments are now in progress. Paper mills are also to be erected under this new power, and contracts for the first of these, a very large plant to make news print, etc., are already closed, it is stated.

THE TROLLEY IN MASSACHUSETTS.—Within the last six or eight years the Massachusetts steam railroads have suffered seriously from trolley competition. Up to 1894 their revenue was larger from their passenger business than from carrying freight. All this has changed, figures showing an excess in revenue from freight in 1901 of over $6,000,000, while in 1894 the excess in revenue from passengers was $3,440,526. An encouragement to the steam roads, however, is to be found in figures showing that the electric street railway lines have steadily been carrying fewer passengers per mile since 1895, while the former have recovered some of their previous losses during the same time. It is now generally admitted that while the street railways of Massachusetts made quite considerable inroads into the business of the steam lines when electricity first became an important factor, which has only been during the past eight or nine years, the latter have proceeded to make some recovery of lost patronage, and that the street railway has become less rather than more threatening. In other words, the trolleys, while establishing a traffic of their own, are now creating new traffic for the steam roads, as it was predicted they would do.

LETTERS TO THE EDITORS.

Improvements in Telegraphy.

To the Editors of Electrical World and Engineer:

Sirs.—The letter of Mr. J. C. Barclay, in your issue of May 24th, in answer to Prof. Pupin's criticism of the unprogressive spirit of the large telegraphic companies calls for a reply in order that the ideas of those who stand for developments in telegraphy commensurate with the advancements of recent years in all other branches of electrical industry may have expression.

Mr. Barclay maintains that Prof. Pupin has not had practical experience in telegraphy, but it likewise appears, judging from the contents of his letter and the example cited by him of a particular automatic system found to be insufficient, that Mr. Barclay is unacquainted with what has been actually accomplished by some of the advanced methods in telegraphy. Speaking from both theoretical knowledge and practical experience, I will briefly state a few facts regarding certain new methods in telegraphy that have been tested. I trust these facts will argue the question: "Have telegraphic methods, as commercially practiced, kept apace with other branches of electrical industry?" It is thought these facts will refute the statement of Mr. Barclay that Prof. Morse "invented the best, cheapest and quickest system of telegraphy that has been introduced up to the present time."

It may be admitted that a system of telegraphy, to be an improvement upon the Morse, should operate better, cheaper and more rapidly than the Morse in one important condition. This condition is that the transmission of the messages may be immediately effected by a single manual operation and that they be either automatically received at the other end of the line ready for delivery, or be at once recorded by pen or typewriter.

The essential feature and the great possibilities of progressive methods in telegraphy are based upon the use of the alternating current for transmitting the signals. By using the alternating current, telegraphy and its possibilities have been as much advanced as light and power distribution by the use of the same current. The alternating current gives a theoretical and practical signalling capacity to long telegraph lines about three or four times as great as the direct current used in the Morse system. Messages can be transmitted over a 1,000-mile duplexed line, without relaying, at a speed of about 650 telegrams of twenty words each per hour. As a single operator cannot transmit messages at such a speed, the operation of transmitting the messages is divided among eight operators, each one simultaneously sending a different message.

The particular method of transmitting and receiving these messages is optional. The messages may be transmitted by operating eight typewriter keyboards and automatically received in printed form on telegraph blanks ready for delivery. Or, by methods known to the writer, any existing telegraph line can be converted, by the use of the alternating current and simple, inexpensive terminal instruments, into an octoplex line, over which eight messages may be transmitted in the form of Morse signals in the usual way and at the same speed per message.

By the use of the alternating current, which will work through condensers and transformers, the main line can be entirely isolated from earth, and thus protected from all disturbances due to earth currents. Other methods enable induction effects to be cut off. By the use of the alternating current complex systems of telegraphic distribution can be established, which are wholly impossible with the Morse system using direct currents. For example, four stations, which may be 100 miles apart, near Chicago, can be in simultaneous communication with four stations 100 miles apart and near New York. For this only one long wire is necessary between the two sets of stations.

The above is but a brief and true outline of some of the advanced telegraphic methods now available for use. Radical changes, which would lead to the destruction of the present system, are not to be expected or desirable. But a progressive spirit on the part of the telegraphic companies which would lead them to investigate and gradually introduce on their lines advanced telegraphic methods would be in keeping with that shown in other electrical fields.

PHILADELPHIA, PA. EDWIN F. NORTHRUP.

Potential of the Clouds.

To the Editors of Electrical World and Engineer:

Sirs.—I trust you will pardon my calling your attention to an error in one of the editorials of the last issue of the ELECTRICAL WORLD (May 24, page 896). I do so, not because it is of any great importance, but because I became interested some time ago in that particular matter, and you may be interested, as I was, to see how little foundation some of our generally accepted ideas really have.

I refer to the statement that the potential of the clouds is raised by the combining of many particles into a few. This explanation is given in almost all the text-books, and has been assumed as correct by many able writers; but it is, nevertheless, incorrect. That part of the potential of a drop of water which is due to the charge which the drop the potential at any particular point is not due to any appreciable extent to the charge which may happen to be on the drop of water at that point. The potential at a given point is equal to $\Sigma \frac{q}{r}$ when q is the charge at any point and r the distance from the point having this charge to the given point, the summation being extended as far as

there are charges affecting the given point. The high potential at any point in a cloud is not so much the effect of the electricity in the immediate neighborhood as to the great amount in all the space about it, and it will make little difference in the value of $\Sigma \frac{q}{r}$ whether the electricity in a cubic kilometer is distributed over a billion or a hundred billion particles.

You will find this discussed by Lodge in "Lightning Conductors," page 5, and more fully by Everett in "Nature," 38, 343.

HAMILTON, N. Y. C. D. CHILD.

[Our correspondent's criticism appears to be valid in so far as relates to the magnitude of the electric potential of an electrified collection of minute spherical particles. The potential at any particular point not near the edge of a cloud of electrified vapor particles will be practically the same whether the particles remain indefinitely segregated or merge and coalesce into larger spheres. On the other hand, however, that part of the potential of a particle which is due to the charge of its own parts will increase according to the rule, as stated in our editorial referred to, and as given in the usual text-books on the subject. The tendency to discharge, and the electrostatic force, will depend on the surface density of the charges, on their potential upon themselves, and on the degree of coalescence. Consequently, although our correspondent is right in regard to the general potential of the cloud, yet we consider that we are also right in regard to the effect of coalescence and condensation upon the production of the ordinary phenomena of atmospheric electricity.—EDS.]

Electrical Works In Germany.

To the Editors of Electrical World and Engineer:

Sirs.—In your issue of April 19th, we find on page 690 a reprint of a consular report, entitled "Electrical Works in Germany." For the sake of the correctness of the data contained in this report I would say that the electric street railway cars of Berlin were built by the Union Elektricitäts-Gesellschaft, whereas the electric current is supplied by the "Berliner Elektricitäts-Werke," a company which is closely connected with the Allgemeine Elektricitäts-Gesellschaft Berlin.

DR. MAX HAMBURGER,
BERLIN, GERMANY. *Engineer of the U. E. G., Berlin.*

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

DYNAMOS, MOTORS AND TRANSFORMERS.

Torque of Tramway Motors.—DODD.—A further communication on this subject. The greatest variation in the torque per ampere at half-load and at full load that is possible is in the ratio of 100 to 200. To have this value it is necessary that the saturation curve of the motor up to the point of rated full load be absolutely straight. To have sparkless running with such conditions, or under anything approaching such conditions, means winding the armature so that the iron section, and consequently the weight of the motor, be practically doubled. A motor designed according to Carus-Wilson's ideas would increase the dead weight by one-fifth of the entire weight of the car, as the ordinary tramcar weighs, loaded, about 11 tons, one-fifth of this being the motors. Further, for roads giving a fast service with a great number of stops, the rate of acceleration is limited by the adhesion of the drivers, and in the greater number of cases only by this. Motors which are not worked to saturation cannot keep to this rapid acceleration long, as they quickly reach the speed corresponding to the starting current. With motors worked to saturation, the initial acceleration is continued to a speed which is well up toward the maximum speed of the trains. For motors which are not worked to saturation, the speed attained by the time the acceleration falls off is only a fractional part of the final speed. It is time that with motors worked to saturation the starting current is greater than with motors designed differently, but the speed cannot be obtained by any other means. For this class of service there is also the fact that motors in which the magnetic circuit is brought to saturation will run at a more nearly constant speed under all conditions of load. Motors operating tramways in the center of a crowded city run at a slow speed, and must be continually slowing and accelerating; for this reason a heavy torque is desired. On the other hand, the weight of the motor must be kept down, as the cars themselves are fairly light. The ordinary tramway motor is more or less of a compromise between these two considerations. The torque per ampere varies between half-load and full load usually in the ratio of 100 to 160, or thereabouts. It is usually found, however, even in this class of service that when slow-speed motors and high-speed motors are installed on the same road the high-speed motors are in great favor with the tramway authorities. For electric railroads operating under steam railroad conditions a heavy weight is not such a great objection. The other two points are, however, of great importance, *i. e.*, ability to attain a high speed quickly and keeping a constant speed under all conditions of load. These two points can be met only by the motor which is worked to saturation.—Lond. *Elec.*, May 16.

REFERENCES.

The Single-Phase Induction Motor.—MCALLISTER.—An article in which an attempt is made to outline the characteristic features of the single-phase induction motor, to ascertain the similarities and the differences between the performances of the single-phase and the polyphase machine, and to investigate the methods by which the single-phase motor may be operated under various conditions.—*Amer. Elec.*, June.

Form-Winding.—DAVIES.—In continuation of his illustrated article on forms and form-winding, he describes forms for field-magnet coils.—Lond. *Elec. Eng.*, May 16.

The Drum Armature.—A didactic article treating of the drum armature. The direction of current flow and e. m. f. generated in each wire are explained and a formula given for the calculation of the latter. The article is copiously illustrated.—*Amer. Elec.*, June.

POWER.

REFERENCES.

Steam-Piping Systems.—ROBBINS.—An article, with diagrams, comparing the steam-piping systems of the four large electrical stations of New York, *i. e.*, the Edison Waterside Station, Manhattan Elevated, Metropolitan Street Railway and the Third Avenue Railway power stations. The plans and cross-sections are given on a very small scale, everything being omitted but the engines, boilers and connecting pipes, together with the outlines of the buildings.—*Amer. Elec.*, June.

The Hartford Steam Turbine Installation.—PERCY.—An illustrated article discussing some of the features which practical industrial tests have developed with regard to the turbine installation of the Hartford Electric Light Company.—*Amer. Elec.*, June.

TRACTION.

Houghton County Street Railway.—PARKER.—A long illustrated description of this road, which has just been constructed. The farthest point reached is 18 miles from Houghton, which is the headquarters of the system. There is also a sub-station at Laurium, about 12 miles from the main station. The power plant comprises two 500-kw direct-connected units, one for railway work and the other for supplying power to three-phase transmission line. The railway generator is rated at 910 amps. and 550 volts at full load, and is guaranteed to stand an overhead of 50 per cent., showing an efficiency of 94 per cent. at full load. The generator for the transmission line is a three-phase, 25-cycle, 500-kw separately-excited machine, running at 100

r. p. m. It has a revolving armature, and develops 500 kw continuously at 380 volts, with an efficiency of 94 per cent. and 750 kw for two hours, with an efficiency of 94½ per cent. There is also a 250-kw, three-phase, 25-cycle Westinghouse synchronous converter rated at 420 amps. at 600 volts on the direct-current side. This converter and those in the sub-station have a full load efficiency of 93 per cent., and were designed for 50 per cent. overload for two hours without injurious heating. The transformer room contains six 100-kw, 25-cycle, oil-cooled step-up transformers, the primary of each being wound for three-phase current at 380 volts and the secondary for 11,000 volts.—*St. R'y Jour.*, May 3, and *Int. Ed.*, May.

Repair Shop.—An illustrated description of the new repair shop of the R. I. Suburban R'y Co. in Providence. The electrical repair room contains pits where repairs to the motors, wheels, etc., can be made, and a new hydraulic hoist is used for removing and replacing the same. There is a transfer table large enough to accommodate a 40-ft. car and operated by an electric motor. There are two air-hoists for carrying wheels and other heavy parts. The winding room has accommodations for re-winding, building and repairing armatures and fields as well as repairing controllers, testing instruments and cash registers. Magneto bells connected with a motor-driven alternator are used for testing the work. There is a hydraulic press for forcing on and off pinions, rings and commutators, operated by a pump having a capacity of 50 tons. The winding room contains three drying ovens, two of which are arranged to contain five armatures each, and a third reserved for drying fields. The ovens are heated electrically. Throughout the entire shop the machines are all motor-driven, power being taken from the 550-volt circuit, two special cables being run from the company's power station.—*St. R'y Jour.*, May 3, and *Int. Ed.*, May

Motor Troubles and Trolleys.—An article in which, as a result of the experience of the present management of the Cincinnati Traction Company, it is announced that the motor troubles and repairs on overhead single trolley systems and on the conduit trolley are much greater than on the overhead double trolley system. Schoepf, Todd aand Dunning, who are now in charge of the management and operation of the Cincinnati lines, have had extensive experience in Washington with the underground conduit road and in Pittsburg with the single overhead trolley road. It is suggested that the trouble on the underground conduit road may be due to the strain on the insulation when the car passes a section insulated with the controller turned full on, as in such a case the sudden breaking of the circuit may cause an "inductive kick" in the field coils. It is also suggested that as the single trolley has a grounded circuit there is a greater strain on the insulation between windings and motor-frames, and that consequently there is greater danger of the insulation breaking down.—*St. R'y Jour.*, May 3, and *Int. Ed.*, May.

Italian Tramway.—An illustrated description of the Bordighera and Ventimiglia tramway in the Riviera. It is 3½ miles long; the overhead trolley system is used. The power station is half a mile from the one terminal of the line; there are two dynamos of 55 kw at 650 volts, driven either by turbines or gas engines. The turbines develop 75 hp, and the gas engines, with Dawson producer gas, 90 hp each. There is also a storage battery, with a capacity of 128 amp.-hrs. —Lond. *Elec.*, May 9.

Rail Bond.—An illustrated description of a new bond. The plugs are of hard bronze and cast into the terminal. One plug has a flange which spreads out the copper of the bond terminal, so as to form a rivet head. After the bond is placed in its hole in the rail the two plugs are pressed toward each other with a screw clamp, and the copper of the web between the plugs is forced out laterally.—*St. R'y Jour., Int. Ed.*, May.

Putting up Trolley Wire in Geneva.—An illustrated note. The Geneva tramway is being changed from horse and steam to electric power, and about 140 km of track has recently been electrified. The old steam dummies were used for this purpose. A construction car carrying a tower and two reels of wire were attached to the dummy, and as the car was drawn over the route the wire was paid out. At intervals the reels were stopped while the locomotive backed slowly to haul the wire taut, after which it was attached in position to the overhead insulators.—*St. R'y Jour., Int. Ed.*, May.

REFERENCES.

Extra Heavy Double Truck.—An illustrated description of this truck, which is especially intended for high-speed electric cars having long car bodies, and is so designed that it will run at an extremely high rate of speed even around curves. It conforms very closely to steam railway practice, having a swing motion and equalizer bar, making a very easy-riding truck. All parts are made extra heavy, and the truck is made for various gages, to suit the requirements of different roads. Each truck is intended to receive two motors.—*St. R'y Jour.*, May 3, and *Int. Ed.*, May.

Birmingham Car Equipment.—An illustrated description of the equipment of the cars to be used in Birmingham. Twelve electric heaters are furnished under the seats, an enclosed arc headlight is provided and there are four dusters of five lights each for interior illumination.—*St. R'y Jour., Int. Ed.*, May.

Open Cars for Lisbon.—A description of these cars, a large number of which have recently been shipped to Lisbon. They are typical open American cars.—*St. R'y Jour., Int. Ed.*, May.

Overhead and Track Construction for Interurban Railways.—HODGES.—A paper read before the New England St. R'y Club. He discusses in detail the mechanical part of the construction.—*St. R'y Jour., Int. Ed.*, May.

Baltimore.—An illustrated description of the Pratt Street station of the United R'y & Elec. Co., of Baltimore.—*The Eng.*, May 15.

Multiple Unit Systems.—P. L.—A continuation of the illustrated serial. This part gives a very well illustrated description of the Thomson-Houston system.—*L'Ind. Elec.*, April 25.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Selector System.—An illustrated description of a "selector" system whose primary application is the control of sub-station and arc-circuit switches from a station. An arc lighting system is considered in which the arcs are connected nine in series across the 440-volt distributing mains. To switch these circuits on or off, it is ordinarily necessary to bring a switching wire back to the works from each series of nine lamps. In the system described, one wire only is to be used, and a "selector" is placed in series on this wire at each of the switching points. A transmitter is used at the works to send different series of electrical impulses to line corresponding with each of the selectors, and the latter are so designed that they close the switch of the arc circuit, which they control, only when the particular series of impulses is received to which they are designed to respond. Ob-

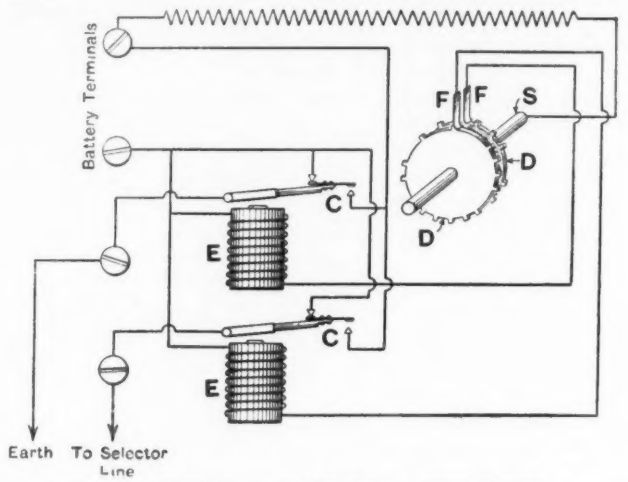


FIG. I.—DIAGRAM OF TRANSMITTER CONNECTIONS.

viously the same arrangement may also be used for other purposes, such as in connection with individual transformers banked at sub-stations. The transmitter which is placed in the central station, is illustrated in Fig. 1. A number of pairs of brass discs, *D*, are mounted on a spindle, *S*, which rotates one revolution when a handle is pulled forward and released; a spring pulling the lever back, drives the spindle through an ordinary train of wheels. There is only one pair of discs shown in the diagram, but in practice there are as many pairs as there are distant switches to be acted upon. Each of the discs has a number of projections on it which make contact with the springs *F, F*. Every time a contact is made, the circuit is closed through one of the electromagnet coils, *E*. These electromagnets act as relays, and when their armatures are attracted, they close the contacts *C, C* of the selector circuit, sending a positive or negative current to line. Each of the different pairs of discs, *D*, corresponds to one selector on the line. Each pair of discs sends a number of impulses in one direction and a smaller number in the reverse direction to the line. But the moments at which the reverse impulses are sent, between two ordinary impulses, differ for the different

pairs of discs. Each of the selectors on the line is so designed that the corresponding switch is only actuated when this particular series of impulses is received. A sketch of a selector is shown in Fig. 2. An electromagnet, *A*, is placed between the two poles of a horse-shoe magnet and is free to move either to the left or right. Each time it is attracted to the left it pulls with it the link *B*, and the pawl *G* pushes the ratchet wheel, *H*, one tooth forward against the action of a spring. The detent *J*, which is also kept bearing on the ratchet wheel by a light helical spring, prevents the wheel from turning back. After a number of impulses, attracting *A* and *B* to the left, a reverse current is received from the transmitter. The arm *B* then moving to the right, *G* comes in contact with the pin *K* and is lighted, and the pin *L* engages with the detent *J* and releases the ratchet wheel. This happens at any selector which is not tuned to the transmitter

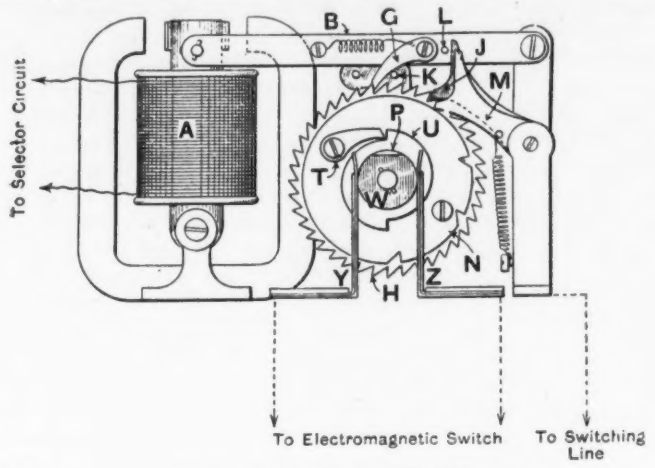


FIG. 2.—DIAGRAM OF SELECTOR.

series of impulses. At the one selector, however, which is to be actuated, a second detent, *M*, is engaged in one of the notches in the plate *N*, which is fixed to the wheel *H*, at that moment and prevents the wheel from returning to its initial position. On the same spindle, but loose on it, is a small barrel of vulcanized fiber, *W*, to which is fixed a small brass plate, *P*, and a snail, *U*, with two notches at opposite diameters. A pawl *T*, fixed on the larger snail wheel, *N*, engages in one of the notches in *U* after the wheels *H* and *N* have made a half revolution forward, and the next impulse being a reverse one, the barrel *W* revolves back with the other wheel. In rotating, the plate *P* makes contact with one of the flat springs, *Y* or *Z*; this closes the circuit of either the switching on or off coil of an electramagnetic switch on the circuit or transformer which the particular selector controls.—Lond. *Elec.*, May 16.

Electric Lighting by Street Railway Systems.—ADAMS.—An article in which he discusses the growing tendency of traction companies to look out for a lighting and power load. Such a load would often be of great advantage, as it would afford a source of large income at a comparatively small increase of fixed charges. Taking the present generating equipment of street railway systems, general demands for electric light and power may be safely supplied in either of the following two ways: If the terminals of each 500-volt d. c. dynamo are brought to a double-pole switch, trolley feeders and track may be connected to one side of this switch and an entirely independent set of circuits for general light and power service to the other. A single throw of the switch for any dynamo connects it to either the traction or the lighting system, so that any of the station dynamos may be operated singly or in multiple on either the lighting or the traction load. The 500-volt current would be at once suitable for motors and for enclosed arc lamps, connected four or five in series. For incandescent lamps a three-wire system would be most suitable, a motor-generator being used for balancing; such a system with 500 volts between the outers could economically distribute energy for lighting and power to a distance of at least three miles from the station. This system, however, requires a separate set of conductors for the lighting service, which, in many cases, would mean a large increase of investment. To make use of existing 500-volt dynamos and of feeder circuits in traction systems for electric lighting at any points to which these circuits extend, small sub-stations are necessary, containing one or more motor-generators and a storage battery.—*St. R'y Rev.*, May 20.

An Up-to-Date Newspaper Plant.—An illustrated article describing the plant of the Lynn *Item*. A large battery is used in connection with the generator and the power bus-bars, which are separated from the lighting bus-bars. All of the unsteady power is taken from the bus-bars to which the battery is connected, and all of the steady power is taken from the bus-bars which are fed directly from the generator. The voltage is thereby kept constant to within 2 per cent. The booster, through which the power and lighting busses are connected, is a motor-driven machine of about 8-kw capacity, and the battery has a capacity of 200 amperes. The generator is a 35-kw machine. The battery is placed under the sidewalk, and is separated from the engine room by a glass partition.—*Amer. Elec.*, June.

Electric Plant of Riva.—An illustrated description of the hydro-electric plant of the city of Riva, in the Tyrol. There are four turbine-driven, three-phase generators, three of 150-hp each, the fourth of 300-hp. The voltage generated is 3,460; the frequency, 50. The electric power is transmitted to Riva and to three neighboring places, where there are 15 transformer stations in fire-proof rooms in houses. The incandescent lamps are connected between a phase and the neutral conductor, the voltage being 110. The motors are operated at 190 volts.—*Elek. Neu. Anz.*, May 1.

REFERENCE.

German Central Stations.—An illustrated description of the electric plant of Karlsruhe, where the three-phase, high-pressure system is used for distribution of electricity for light and power; the power station contains three steam alternators, each of 560-kw, at 4,000 volts per phase and 50 cycles per second. Also a brief description of the small direct-current station of Mosbach, where the two-wire system, at 220 volts, is used; it contains a 90-kw dynamo, a battery of 130 cells of 600-amp.-hours capacity and a booster set of 18 kw; the small cables or feeders consist almost entirely of aerial wires, carried on poles and over the tops of the houses. Lond. *Elec. Rev.*, May 2.

WIRES, WIRING AND CONDUITS.

REFERENCE.

Determining Wire Sizes for Alternating-Current Motor Circuits.—An article with comprehensive diagrams and tables for calculating the sizes of wire for alternating-current motor circuits with various drops. The diagrams are plotted for power factors from 80 per cent. to 98 per cent. in steps of 2 per cent., and for wires three inches apart. The tables are for wire sizes up to No. 10, and are applicable to both 200 and 400-volt circuits of 60 cycles frequency, with the wires three inches apart, and cover single-phase, two-phase and three-phase circuits.—*Amer. Elec.*, June.

ELECTRO-PHYSICS AND MAGNETISM

The Role of Water-Vapor in Gaseous Conduction.—LEWIS.—A note in which he discusses the opinion expressed by Trowbridge that pure gases, hydrogen in particular, are perfect insulators, and that the presence of a trace of water-vapor or oxygen is necessary to produce the dissociation or other conditions upon which conduction depends. He agrees that this view does not seem improbable, when one considers the more or less analogous phenomena of electrolytic conduction in solutions. He, nevertheless, hesitates to accept Trowbridge's conclusion. He says that some of the reasons given for believing pure hydrogen to be an insulator are not conclusive. It seems impossible to eliminate all traces of impurity from vacuum tubes, and it may be that one or more such impurities may take a very active and essential part in the processes which transform a gas into a conductor; but as, under conditions described by him, comparatively small electromotive forces can drive a current through hydrogen or nitrogen, it seems at least doubtful whether water-vapor is necessary to gaseous conduction.—*Phil. Mag.*, May.

Preparation of Radio-Active Surfaces.—ELSTER AND GEITEL.—A description of the preparation of radio-active surfaces. The best form of conductor to be made radio-active is that of a wire, either copper or aluminum, about 0.5 mm. thick, and not shorter than 10 meters. All that is required is an influence machine or induction coil for maintaining the wire at a negative potential of about 3,000 volts for three or four hours. At the end of that time the wire has acquired a radio-active surface layer capable of discharging an electroscope or producing a photographic impression through black paper or aluminum foil. The activity is only temporary, but lasts for several hours. The active surface of the wire may be rubbed off and so transferred to leather, and obtained in a concentrated form for photographic purposes. They have succeeded in preparing active surfaces on leather in the manner indicated, whose activity equals

that of uranium ore.—*Phys. Zeit.*, April 15; abstracted and commented upon editorially in Lond. *Elec.*, May 2.

Invalidity of Ohm's Law.—Stark.—A paper in which he discusses Ohm's law from the point of view of the electron theory. He formulates an equation, stating that the current density of the negative ions is proportional to their charge, their specific velocity and the force moving them. He shows that the limit of the validity of Ohm's law is reached as soon as the difference between the driving forces at the beginning and at the end of the mean free path ceases to be small in comparison with the driving force itself. This may happen whenever, owing to some sudden change of medium, there is a surface accumulation of ions producing a strong electric field, or where, owing to exhaustion, the mean free path of the electrone is of visible length. It is well known that in the vacuum glow discharge the electric force is very great immediately at the cathode, whereas in the negative glow light it is little more than zero. The distance between the cathode and the negative glow light is smaller than the mean free path of the negative ions. There is, therefore, a steep slope of electric force just in that locality, and hence also the well-known invalidity of Ohm's law in the same place.—*Ann. d. Phys.*, No. 4; abstracted in Lond. *Elec.*, May 2.

Faraday Effect.—Du Bois.—A paper in which he says that the Faraday effect of a magnetic field on light is either positive or negative for the compounds of the different metals of the erbium series. The salts of cerium, praseodymium, neodymium, samarium, gadolinium, erbium and ytterbium are strongly paramagnetic, and the absorption spectra of cerium, gadolinium and yttterbium show peculiar lines and bands. He believes that researches made upon these three metals in connection with the magneto optic properties, are bound to yield valuable data for theoretical progress. He has not yet succeeded in finding any effect of a magnetic field upon the very characteristic absorption of the strongly magnetic erbium chloride solution. Experiments should be made, if possible, upon the absorption bands themselves.—*Ann. der Physik*, No. 4; abstracted in Lond. *Elec.*, May 2.

Electro-Chemistry and Batteries.

Temperature Variations of Specific Molecular Conductivity and of Fluidity.—Lyle and Hosking.—An account of experiments made to test the statement often made that the temperature variations of electrical conductivity and fluidity are identical for a given electrolytic solution. They investigated sodium chloride solutions. From the results obtained, they are able, by interpolation, to compare the electric conductivity and the fluidity over the range of temperature between 0° C. and 100° C. of solutions of constant concentration; *i. e.*, they compare the conductivity and the fluidity at different temperatures of such solutions as contain, say, 1 grammolecule per liter at each of these temperatures. The curves obtained by them are remarkable in that they indicate that for solutions of the strengths experimented with both the fluidity and the specific molecular conductivity vanish at a temperature of − 35.5° C. The temperature coefficients of fluidity and specific molecular conductivity are not identical, though the two sets of curves possess considerable similarity.—*Phil. Mag.*, May.

REFERENCE.

Design of a High-Capacity Storage Battery.—Brocksmith.—An article describing and giving working drawings of a high-capacity storage battery, to be used in connection with an electric motor cycle, described in previous issues. The cell has three positives and four negatives, giving a total positive active surface of 136 sq. ins. The weight of the cell complete is 9½ lbs., and gives a current on short circuit of 375 amperes, or 14.2 watt-hours per pound of complete battery.—*Amer. Elec.*, June.

Units, Measurements and Instruments.

Measuring the Temperature of Furnaces.—Fery.—A description of a radiation scale of temperature in the form of a practical method of aping Stefan's law to the measurement of temperatures. Stefan's law states that the radiation of an absolutely black body is proportional to the fourth power of its absolute temperature. A temperature may thus be measured in the same way as a brightness. By an absolutely black body is meant one which absorbs all the heat it receives and gives it out again by radiation, and not by reflection. Kirchoff has shown that the interior of an enclosure whose walls are at a uniform temperature behaves as an ideally black body. A furnace with a small opening is practically such an enclosure, and since it is usual that the temperature which is wanted is that of a furnace, the application of Stefan's law becomes at once a matter of great value. Fery uses a kind of telescope with fluorspar objective, which concentrates the radiation upon a thermo-couple. He has found that the absorption of radiant heat by the fluorspar increases in proportion to the amount of incident heat at temperatures above 900 degrees. Hence, the only noxious effect of the fluorspar is to reduce the sensitiveness by about 10 per cent. The lens is focused for parallel rays, and an inner diaphragm is so arranged that only a certain cone of rays is received upon the thermo-couple, thus rendering the range independent of the distance of the hot body. A comparison between the new thermometer and a Le Chatelier pyrometer shows an error well below 1 per cent. at temperatures from 914 up to 1,450 degrees, the highest temperature of comparison. The indications are very rapid, the mass to be heated being less than a hundredth of a milligram. The zero is also very exact and constant. He has measured the temperature of the positive arc carbon by his instrument and found it to be 3,490 degrees. The chief attraction of the new instrument is its enormous range. At temperatures at which platinum melts and all thermo-couples forsake us, and even air-thermometers lack a fire-proof enclosure, the radiation thermometer only needs a readjustment of sensitiveness to make it perfectly correct. This assumes, of course, the universal applicability of Stefan's law, which appears to be guaranteed, as it is based upon well established principles of thermodynamics. The only limit we can assign to its range is the capacity of the ether to convey electromagnetic waves of high amplitude in accordance with the law of inverse squares.—*Comptes Rendus*, April 28; abstracted and editorially discussed in Lond. *Elec.*, May 16.

Calibration of Thermo-couples.—Berthelot.—A paper in which he gives some valuable hints with regard to the use of thermo-couples in pyrometry. The cheapest and most satisfactory combination appears to be that of platinum with a 10-per-cent. alloy of platinum and iridium. He believes that the anomalies sometimes encountered in the behavior of this and other couples are due entirely to a chemical change which they undergo in a reducing atmosphere, such as exists in some parts of a Bunsen burner. In any case, these irregularities are never seen in an atmosphere of air, nitrogen, or carbonic acid. Within the temperatures of 400 and 1,100 degrees, the curve representing the relation between the e. m. f. and T is practically a straight line. The fixed points used by him are the melting point of zinc, 419 degrees, and the melting point of gold, 1,064 degrees. The latter is best applied by inserting a piece of gold between the elements at the hot junction, and taking the reading at the instant when the gold melts, and thus breaks the contact. The melting point of sulphur, 445 degrees, is not to be recommended unless the minute precautions prescribed by Heycock and Neville can be fully observed.—*Comptes Rendus*, April 28; abstracted in Lond. *Elec.*, May 16.

Electricity Meter.—An illustrated description of the Mordey-Fricker meter, which is intended either for direct or alternating current. It is a combination of an ordinary clock with a galvanometer coil surrounding a soft iron needle. The clock is deprived of its hair-spring, and carrying on its balance-wheel shaft a disc of slate, on which a few pieces of iron wire or iron strip are fixed in the manner of a compass card. This disc is surrounded by a fixed coil of wire, conveying the current to be metered. The disc acts as a variable hair-spring. The iron which it carries is magnetized more or less strongly by the current, a directive action being exerted in an opposite sense to that acting on a galvanometer needle—that is to say, tending to bring the iron needle to a central or axial position in the coil. This action, in conjunction with the ordinary action of the driving spring of the clock, causes the disc to oscillate at a rate directly proportional to the current. The meter does not go at all when no current is passing, for there then being no directive action on the iron, the disc comes to rest at one or other extreme of its arc of oscillation. The balance-wheel shaft is carried on a footstep jewel, but in order to relieve that jewel of pressure and prevent risk of injury to it, a tortionless silk fiber suspension is used, attached to the shaft by a bent wire spring; but the meter works quite well without this suspension. The meter is an ampere-hour meter, but for use on constant-pressure circuits the counter, which is geared to the clock, is arranged to indicate the consumption directly in kw-hours. The meters may be wound for any pressure, and, moreover, it is asserted that with alternating currents there is no frequency error, the constant being the same for all practical frequencies. The starting current is said to be extremely small, corresponding to a single 5-cp or 8-cp lamp, but the

total capacity is not given. The pressure drop due to the resistance of the coil is about 0.7 per cent. at full load. One winding of the clock-work is enough to last for about three months; it has not been thought necessary to introduce the complication of an automatic self-winding gear. An ordinary eight-day clock movement is used. The instruments are intended especially for small installations, say, of 12 to 30 lamps.—Lond. *Elec.*, May 16.

TELEGRAPHY. TELEPHONY AND SIGNALS.

Wireless Telegraphy.—A note on an "illustration," by Fleming, at the recent conversazione of the (Brit.) Royal Society, of Zickler's proposed method of wireless telegraphy, which utilizes the fact that ultra-violet light promotes electric discharge. There are two spark-gaps in parallel. The larger one is made to spark more easily than the other, by exposing it to the feeble ultra-violet glow of a Leyden jar; but when, on the shorter gap, a distant naked arc light is focused by means of a concave mirror, the sparking action is transferred from the long gap to the shorter. Interruption of the arm beam by a glass plate, which robs it of its ultra-violet rays, restores the original state of things, which would thus be set up and maintained for long or short periods. Thus we have dots and dashes carried along the light beam and recorded on moving paper submitted to the burning action associated with the longer spark-gap.—Lond. *Elec.*, May 16.

Cable Relay.—A note on an exhibition, by Muirhead, at the recent conversazione of the (Brit.) Royal Society, of a cable-relay operating between two circuits of artificial cable, each representing 1,250 nautical miles, with an automatic transmitter at the sending end of one circuit and a siphon recorder at the receiving end of the other circuit. "In the relay the local contacts are made between a metallic arm, which is connected by fibers to the signal coil, and a vibrating body whose metallic surface is divided by thin insulating partitions into three sections, to constitute the two terminals of a local line or re-transmitting battery with a zero section between." This issue contains also the first part of an illustrated reprint, in full, of Brown's paper on a cable-relay, an abstract of which was recently noticed in the Digest.—Lond. *Elec.*, May 16.

REFERENCES.

Telephone Engineering.—DOMMERQUE.—Another article of the series on telephone engineering, dealing with the preliminary considerations as to the wire plant. The three classes of wire plant are considered: the overhead, the partly overhead and partly underground, and the underground.—*Amer. Elec.*, June.

Cable Steamer.—A brief illustrated description of the new twin-screw cable steamer "Colonia," which is the largest cable ship afloat, and has a carrying capacity of 4,000 nautical miles of cables in her four tanks.—Lond. *Elec.*, May 16.

MISCELLANEOUS.

Radiation Cures.—An editorial note stating that there can be no doubt that pathogenic germs, active upon the human organism can be exterminated, if only they can be reached and persistently acted upon by intense radiation. Herein lies the supreme obstacle to the application of radiation cures; only when the seats of the disease are upon the surface of the organism can this remedy be found effective, but not for deep-seated diseases. "In the early days of the glow lamp, it used to be a popular experiment to light up a tiny lamp inside the stomach of a fish. Possibly in this harmless experiment lay the beginning of a new and now only partially developed method of treatment of organic disease." The same issue contains an illustrated description of some light baths and light cure apparatus, made by a London firm.—Lond. *Elec.*, May 16.

Self-Electrification of the Human Body.—HEYDWEILLER.—An account of experiments in which he found that charges of opposite sign may exist on different parts of the body without giving rise to a neutralizing electric current. He charges the needle of a quadrant electrometer to several hundred volts. One of the pairs of quadrants is put to earth, while the other is joined up to an insulated metal plate. If now one hand is held in the neighborhood of the plate, without touching it, and the operator mounts upon an insulated stand, the electrometer gives a considerable deflection, showing a negative charge of the hand, which only disappears slowly. The deflection indicates a charge of nearly 1,000 volts. This charge is not due to the friction of the clothes, as it is the same without them. Bending the knee produces an opposite charge. The charges correspond in every case to the well-known muscular currents. But the novel observation is that these charges can exist for some time without neutralizing each other. This is attributed by the author to the existence of badly conducting layers in the epidermis. The energy displayed in producing these charges is very small in comparison with the mechanical work. He puts it at about 250 ergs.—*Ann. d. Phys.*, No. 5; abstracted in Lond. *Elec.*, May 16.

Electricity and Plant Growth.—A brief note stating that Lemstroem has recently carried out some experiments in Helsinfors, in which the growth of vegetable and other crops was stimulated by means of electricity. The crops obtainable from arable land of medium quality showed an increase of 45 per cent., while on poor soil the effect was trifling. Peas, cabbages and turnips among certain plants were only affected after being watered, but most plants were injured, if submitted to the influence of electricity during hot sunshine. No further information is given, but it is estimated that the method can be made to pay when applied to agricultural purposes.—Lond. *Elec.*, May 16.

Electro-Therapeutics.—MRS. MAUREL.—An account of the use of electrical methods in therapeutics at the General Hospital of Tours during the last six years. There are four wards for this purpose; one contains the old apparatus for treatments with inductive coils and influence machines; the second is furnished with X-ray apparatus and high-frequency machines, together with an Oudin resonator; the third and fourth are set apart for gynæcology and galvanocautery, respectively. In five years, up to July, 1901, 717 cases have been treated, 207 of which were sent for electro-diagnosis, while the rest consisted largely of cases of hemiplegia, rheumatism, uterine affections and constipations. The radiagraphs taken numbered 217.—*Arch. d'Elec. Med.*, April; abstracted in Lond. *Elec.*, May 9.

New Books.

KONSTRUKTIONSTAFELN FUR DEN DYNAMOBAU. By Prof. E. Arnold. New Edition. Stuttgart: Ferd. Enke. Two board portfolios of 60 sheets each. Price, per portfolio, 20 marks.

As the title implies, these are loose sheets of engravings reproduced from scale drawings of electric generators, motors, transformers, etc. The sheets of one portfolio are devoted to direct-current machines, and those of the other to alternating-current designs. Each portfolio contains also an index sheet and a data sheet, the sheets of drawings showing only dimensions and general data, such as output, voltage and speed. The designs covered are mostly of thoroughly modern types, and many of them might readily be taken for standard American machines. They are all taken from actual European practice, the machines having been built by such establishments as Allgemeine Elektricitäts-Gesellschaft; Siemens & Halske; Oerlikon Works; Brown, Boveri & Co.; Lahmeyer & Co.; Ganz & Co., etc.

A disappointing feature is the absence of detail data for some of the design sheets. Only the drawings, and some of these not completely dimensioned, are given for thirty-two of the direct-current and twenty-five of the alternating-current designs, the remainder, however, being made complete by the data sheet. The designs that are given in full should be of immense advantage to designers who desire to avoid most of the preliminary experimentation that invariably accompanies the preparation of new lines. The data are extremely full—in fact, the electrical and magnetic data are absolutely complete. Among the induction motor designs one finds litttle difference from American practice, the only noticeable difference being in the use, by one maker, of stator teeth overhanging the slot on one side only, and by another of a hole winding. In the transformers there are many differences, the most radical being three-phase apparatus. The alternators are themselves closely similar to the best American practice, but many of them differ from that practice in having their exciters mounted on the generator shafts.

TRANSACTIONS OF PACIFIC COAST ELECTRIC TRANSMISSION ASSOCIATION. Fifth Annual Convention, 1901. San Francisco, Calif. 209 pages, illustrated.

This volume contains 17 papers, and several discussions, at the San José Convention of the Association, June, 1901. The Association has 62 members on the list, divided with even-handed partiality between 31 associates and 31 members (six of whom are honorary members). Twelve of the papers are on high-potential switches, showing the importance of those articles in the business

to whose fostering the Association is devoted. Two papers are on pole-lines, one on electric pumping, one on telephone service, and one on climatology of California from the standpoint of the meteorologist interested in lightning. All the papers are well insulated, and the transactions in general are very interesting, with a distant far-western flavor that is both characteristic and delightful.

As regards high-potential switches, the consensus of opinion seems, from the discussion, to have been against employing them, or, where they may be employed, against using them. The high-potential switches seem to require a very large amount of free space in which to break the arc at rupture. Oil switches, remote from the switchboard, buried in brick vaults and governed by pilot-switches from the switchboard, seemed to meet with favor.

BOOKS RECEIVED.

Physical Determinations. Laboratory Instructions for the Determination of Physical Quantities. By W. R. Kelsey, B. Sc., A. I. E. E. London: Edward Arnold. 316 pages, illustrated. Price, 4 shillings and sixpence.

Das Elektrotechnische Institut Zu Carlsruhe. By Prof. E. Arnold. Berlin: Julius Springer. 60 pages, 29 illustrations.

The Arithmetic of Electrical Measurements. By W. R. P. Hobbs, R. N. Revised to date by Dr. Richard Wormell, M. A. Ninth edition. London: Thomas Murby. 112 pages, illustrated. Price, 50 cents.

Directory of Electrical Societies, Etc.

American Association for the Advancement of Science. Next meeting, Pittsburg, June 28 to July 3, 1902.

American Electochemical Society. Next meeting, Niagara Falls, N. Y., Sept. 15, 16 and 17, 1902.

American Institute of Electrical Engineers. Annual convention, Great Barrington, Mass., June 18-21, 1902.

American Street Railway Association. Next meeting, Detroit, Mich., Oct. 8, 9 and 10, 1902.

Association of Railway Telegraph Superintendents. Next meeting, Chicago, June 18, 1902.

Association of Edison Illuminating Companies. Next meeting, September, 1902.

Canadian Electrical Association. Next meeting, Quebec, June 11, 12 and 13, 1902.

Independent Telephone Association of Wisconsin. Next meeting, Waupaca, Wis., June 25, 26 and 27, 1902.

Independent Telephone Association of the United States. Next meeting, Philadelphia, Pa., June 24, 25 and 26, 1902.

International Association of Municipal Electricians. Next meeting, Richmond, Va., Oct. 7, 8 and 9, 1902.

National Electric Light Association. Next meeting, Chicago, May, 1903.

Northwestern Electrical Association. Next meeting, Waupaca, Wis., June 25, 26 and 27, 1902.

Ohio Street Railway Association. Next meeting, June, 1902.

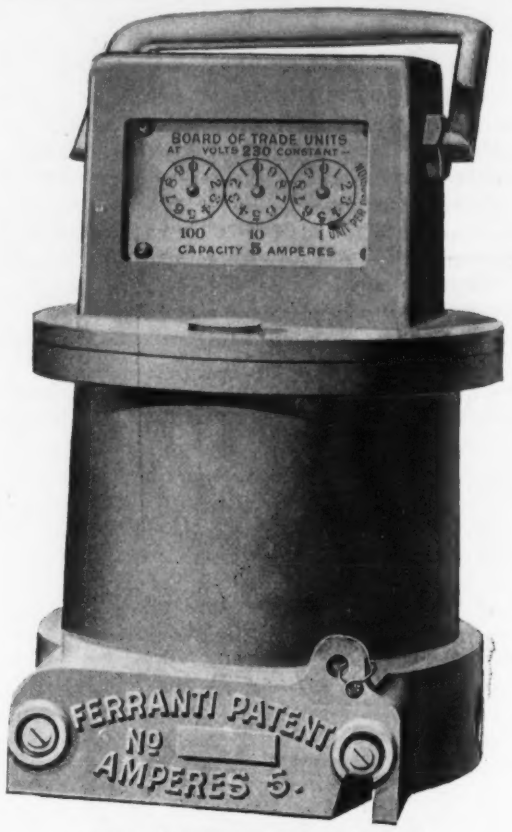
Old-Time Telegraphers' Association and United States Military Telegraph Corps. Next meeting, Salt Lake City, Utah, September, 1902.

Society for Promotion of Engineering Education. Next meeting, Pittsburg, June 28 to July 3, 1902.

Ferranti Direct-Current Meter.

The accompanying illustration shows a type of direct-current meter made by S. Z. de Ferranti, London, Eng., which has been laregly adopted in British central station. The meter illustrated is for 6 amperes, and is provided, as will be seen, with a handle, which is fitted to all meters of this type of 100 amperes and under. This is found of much convenience in handling the meters, and prevents the spilling of mercury when the meter is being carried; when not in use the handle turns down.

The meter is of the mercury motor type. The current is conducted to the center of a mercury bath, through which it flows radially to a contact ring which is connected with a coil surrounding a pole piece immediately under the mercury bath. The bath is insulated on the top and bottom by means of fiber, and is thus the armature of a motor of the unipolar type. The electromagnet action between the magnet and the current passing through the mercury causes the latter to revolve. The driving torque set up by the current varies as the square of the number of amperes, but as the resisting torque set up by the



FERRANTI DIRECT-CURRENT METER.

fluid friction varies as the square of the velocity, the result is a velocity directly proportional to the number of amperes passing through the meter. A light fan, consisting of four vanes, is completely immersed in the mercury and moves with the mercury, the motion of the fan being communicated by means of a worm and gear to a registering mechanism.

Improvement in Field-Magnet Construction.

In a paper read at a recent meeting of the Ohio Society of Mechanical, Electrical and Steam Engineers, Mr. S. E. Huenerfauth described a method adopted by the Phoenix Electric Manufacturing Company for obtaining sparkless commutation without excessive weight of material or expenditure of power. The method consists broadly of the use of slotted magnet poles, without pole shoes, commutating tips being formed by hollowing out the cores just above the pole face on each side of the magnet core. The accompanying illustration, reproduced from a photograph of a rough casting, shows a field of this form.

With this form of pole, the hollows above the pole tips reduce the cross-section of the steel so that at no load the outer ribs are highly saturated magnetically at the hollows; consequently the magnetization of the pole tips varies very little from no load excitation to maximum, and the commutating fringe under the pole-tips remains nearly constant. This construction, combined with the use of slots nearly across the pole face, prevents distortion of the field flux by armature reaction, and allows the brushes to remain fixed between no load and full load.

The slots in the pole-face further serve to connect the wider slots on the body of the pole with the armature chamber and supply superabundant ventilation to the field coils, carrying away heat from the inside of the coils, whence it is ordinarily least able to escape. Moreover, the use of polar horns or extensions being rendered unnecessary, the outline of the body of the pole is made the same as a projection on the pole-face outline, so that the field-magnet coils may be slipped off without using removable poles—the poles being cast integral with the yoke-ring.

It was stated that a 150-kw Phoenix machine with a reactive

voltage of 11½ volts per coil is running in an adjacent city without showing the slightest indication of sparking at the brushes. The advantage in carrying the reactive voltage up is that it reduces the cost of construction. A reduction of reactive voltage means increased armature diameter, increased number of armature coils and consequently commutator segments. Anyone who has tried

NEW FORM OF FIELD MAGNET.

to build a 24-inch commutator with 600 or more segments will appreciate the removal of the necessity for a large number of coils.

Still another benefit derived from the use of the slotted form of magnet core is that the metal of the pole-face is highly saturated, while the density in the air-gap is quite normal. This supplies an additional barrier to the distortion of the field by armature reaction, without resorting to highly saturated armature teeth, with the accompanying hysteresis loss. A 200-kw machine recently built showed a total armature core and friction loss of 2¼ per cent., and a practically distortionless field was obtained with an excitation of less than 1 per cent.

From an actual test made of a 150-kw generator, after a five hours' run, the field-coils were cooler by 5 degrees on the inner surface of the coil than on the outer. It was also discovered that by holding a small strip of paper at the opening of the slots at the top of the field-coils the current of air would draw the paper toward the opening. When the armature is in motion, the tendency is to draw the air through the opening at the top, down through the slots on the face of the pole-block, where it has the effect of materially cooling the face of the armature.

Charlestown Power Station of the Boston Elevated Railway.

The surface and elevated lines included under the corporate management of the Boston Elevated Railway are furnished motive power from eight power stations, viz., the Central, Harvard, Lincoln, Dorchester, Allston, Charlestown, East Cambridge and East Boston stations. These stations, as will be seen, are quite widely distributed, although all are operated in parallel except the East Boston station.

Especial interest centers at present in the Charlestown station, where the first of two large power units, recently installed, is shortly to be put in operation. In order to accommodate this unit an addition to the original power house was necessary. The equipment of the old station consists of three 500-hp boilers of the Babcock & Wilcox type and two horizontal cross-compound Allis engines rated at 1,000 hp each. These engines are direct-connected to multipolar generators of 800 kw capacity.

In order to take care of the largely increased demands of the public service it was found necessary to enlarge the power equipment at Charlestown, and it was determined to install an engine of sufficient size and stability to meet at all times the severe demands of high-class service under the existing conditions. A Westinghouse vertical cross-compound engine was chosen as the best type obtainable for this work, the order being placed through the Boston office of Westinghouse, Church, Kerr & Co. This engine has two cylinders, 44 and 87 inches in diameter, with 60-inch stroke,

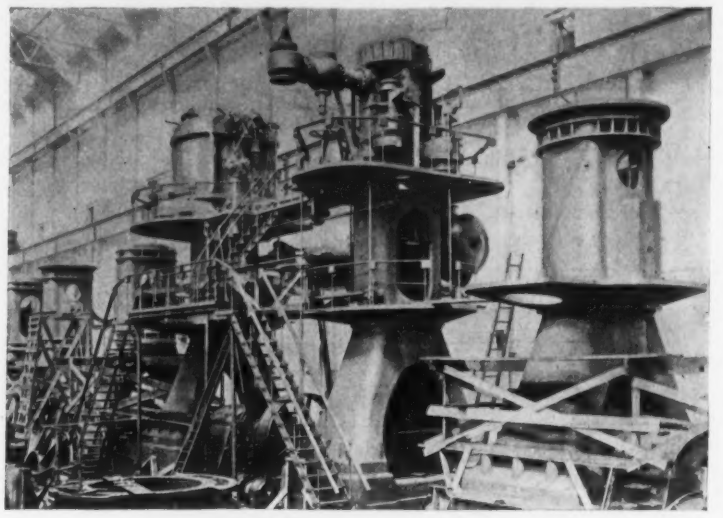


FIG. 1.—CHARLESTOWN ENGINES IN COURSE OF ERECTION.

and runs at 75 r.p.m. It is given a nominal rating of 4,500 hp, using steam at 160 pounds initial pressure with a vacuum of 26 inches, and has an ultimate capacity somewhat exceeding 7,000 hp.

The high-pressure cylinder is fitted with poppet valves for use with superheated steam, and the low-pressure cylinder with a Corliss valve gear of Westinghouse design. The cast-steel fly-wheel is 28 ft. in diameter with 26-in. face, and weighs 150,000 pounds. The shaft is of hydraulically forged steel, 37 in. in diameter, with an 18-in. hole in the centre. The total weight of the complete engine is, approximattely, 1,125,000 pounds.

The armature of a Westinghouse direct-current generator is carried on the main shaft between the high and low pressure cylinders. This is one of the four largest direct-current railway generators in New England. It is a 24-pole machine of 2,700 kw capacity. The commutator and armature are 12 and 15 feet in diameter, respectively, and the total weight of the generator is about 338,000 pounds.

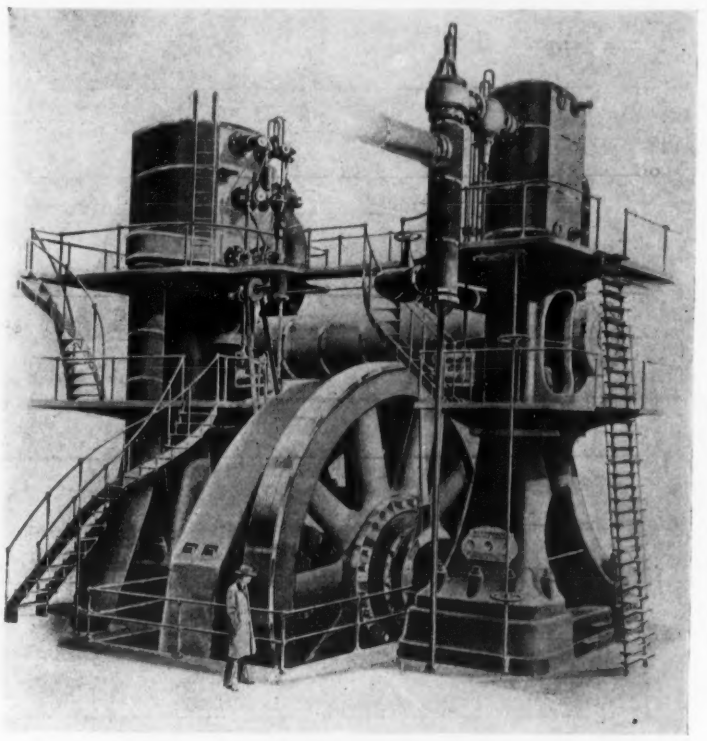


FIG. 2.—ONE OF THE COMPLETE UNITS.

An interesting feature of the switchboard installation, which was

also designed by the Westinghouse Company, is to be found in connection with the circuit breakers, which can be thrown out from any portion of the building by means of electric buttons.

The condensing system includes two Allis condensers for the small engines built by the Allis Company, and a Bulkley jet condenser for use with the Westinghouse engine.

The capacity of the boiler room has been increased by adding four 500-hp water-tube boilers, built by the Aultman & Taylor Company, of Mansfield, O. Coal is supplied to the power house direct by rail and loaded from cars into overhead hoppers, although the power house is located so that coal can be brought by either water or rail. The boilers are equipped with Green economizers, arranged in the usual manner with by-pass flues for leading the gases direct to the stack, should occasion require. The method employed for the removal of ashes is of particular interest. The overflow from the condensers and pumps is carried through trenches, which pass under the ash-pits of the boilers. The ashes can be dumped at will into these trenches, and are carried off with the overflow to flats or meadows, which are being filled and enclosed.

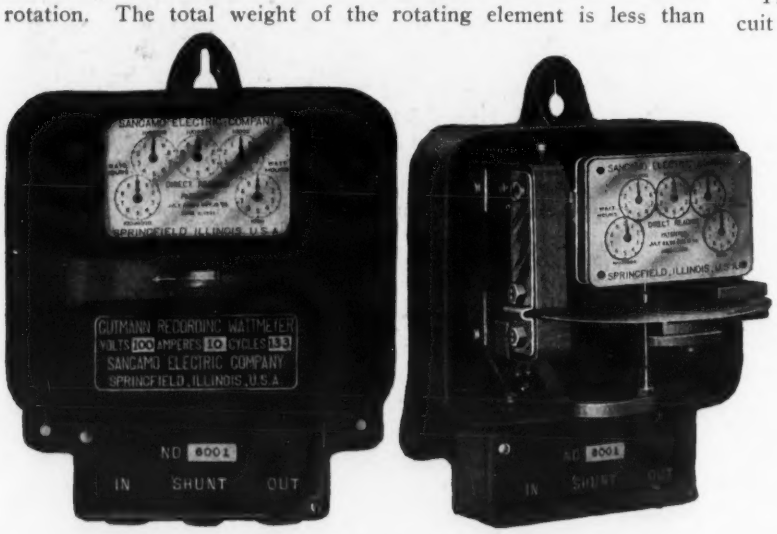
While the new boilers were primarily installed for the purpose of furnishing steam to the Westinghouse engine, the scheme of piping has been carefully arranged so that the boilers may supply steam to any engine. Cylinder oil for the entire station is forced by city water pressure from a tank located in the basement.

The scheme of electrical distribution and auxiliary equipment has been carefully worked out. The details of this as well as the general installation of the additional power equipment has been under the direct supervision of Mr. C. S. Sergeant, vice-president, and Mr. C. F. Baker, superintendent of motive power and machinery for the Boston Elevated Railway Company.

The Gutmann Wattmeter.

A new type of Gutmann integrating wattmeter for alternating current has been designed to replace an earlier form, which has been on the market for three years, and has met with excellent results. The new meter, however, is superior to it in several important points. It is a sealed type induction wattmeter, very small, simple and durable, and, it is claimed, lighter than any other meter on the market, its weight being 10½ pounds.

Fig. 1 shows the meter with the aluminum case or cover in place, and Fig. 2 shows it with case removed. Fig. 3 shows the rotating element, a very light aluminum disc mounted on a short steel spindle, the disc being slotted in certain spiral curves, which define the paths of the currents induced in the disc so as to cause rotation. The total weight of the rotating element is less than



FIGS. 1 AND 2.—INTEGRATING WATTMETER.

¾ of an ounce, and by the use of a broad-rounded pivot and carefully selected jewel with so light a rotor, any danger of injury to the jewel or spindle in shipment is eliminated.

Owing to the large number of turns in the shunt coil and the unusually low reluctance of the shunt magnet, the constant loss in a 100-volt, 133-cycle meter is less than one watt, and less than 1½ watts in a 100-volt, 60-cycle meter. The series coils of the meter, located exactly opposite each other, above and below the disc, have as few turns as possible to produce a strong torque on the disc; so that the drop through any size at full load is only a small fraction of a volt. The torque in the meter is high, as it is necessary to preserve its accuracy in service.

The damping magnet is the same in design as that which gave excellent results in the first Gutmann meter, and is easily adjusted in calibrating the meter. On the shunt magnet is an ingenious adjustment for "light load" or friction, and also a device by which every meter is exactly "compensated" for inductive load of any power factor, so that neither leading nor lagging current affects its accuracy. The "compensation" is effected by adjusting a small loop of iron or copper wire, which closes a gap in a copper band about the shunt magnet. It is thus very easy to change a 133-cycle meter to 60 cycles, or vice versa, by first altering this loop, and then readjusting the permanent magnet, the entire operation requiring but a few minutes.

The connecting box is a particular feature of the meter, being very simple, and convenient for installation. The box is part of the

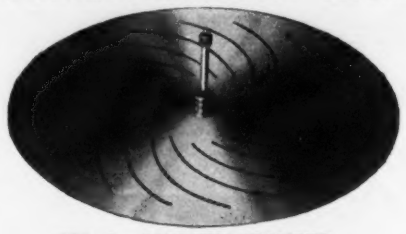


FIG. 3.—ROTATING ELEMENT.

meter, but separated from the sealed working portion by a dust-proof and water-tight wall.

All sizes of the new meter, up to 200 lights capacity, read direct in watt-hours upon the dial, without a multiplier, and the enameled dial is large and easily read in dark corners. For three-wire single-phase circuits the meter is made with four binding-posts, two for each of the outer wires, there being no shunt post, as the shunt coil is connected inside. All sizes record accurately from a very small percentage of full load to a large overload, the accuracy being unaffected by wide variations in frequency or voltage. The three-wire meters are also correct under any conditions of unbalanced load. For sizes above 100 amperes, the meters are furnished with series transformers, and for primary circuits, with potential transformers. The Gutmann meter is manufactured by the Sangamo Electric Company, Springfield, Ills.

New Forms of Circuit Breakers.

The Cutter Company, of Philadelphia, is making a type of circuit breakers, illustrated herewith in Fig. 1, having, in addition to

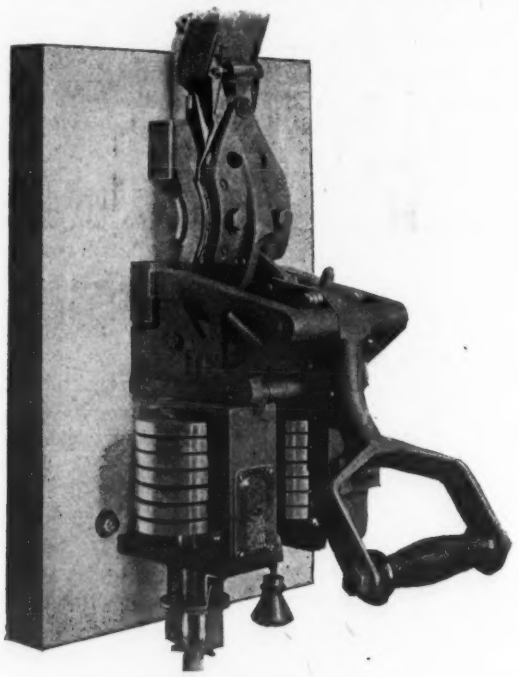


FIG. 1.—REVERSE CIRCUIT-BREAKER.

the regular overload function, a "reversal" feature. Where generators are operated in parallel, a slowing down of the prime

mover of one or more of them, or an interruption of any one of the field circuits, is apt to cause serious disaster if not properly guarded against, the tendency of the generator with which the difficulty begins being to run as a motor, naturally resulting in mechanical injury to it, and often causing the overloading of the others. The "Reversal Feature" prevents such damage by fore-

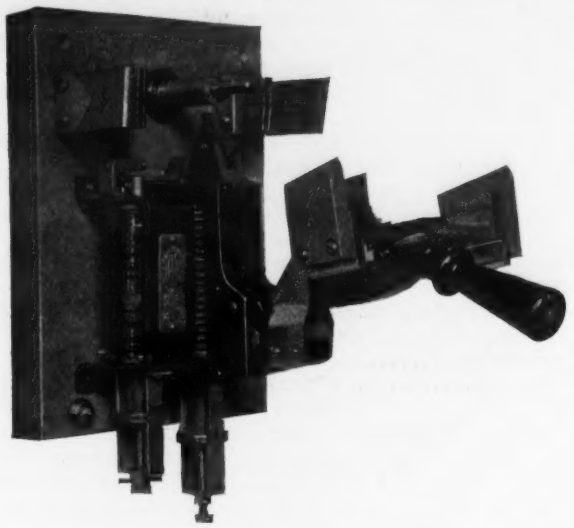


FIG. 2.—SINGLE-POLE CIRCUIT BREAKER.

stalling its cause, effecting the operation of the circuit breaker, with which it is connected, as soon as the reverse current through it reaches a measurable value. The I-T-E reversible circuit breakers can be made to operate on the "reversal" only if desired. The capacities are from 5 to 5,000 amperes.

Fig. 2 shows a type of circuit breaker, made by the same company, which is particularly adapted for use in connection with motor-driven tools, printing presses and traveling cranes. In addition to the usual overload coil, it is provided with an auxiliary coil of high resistance, by means of which the instrument may be

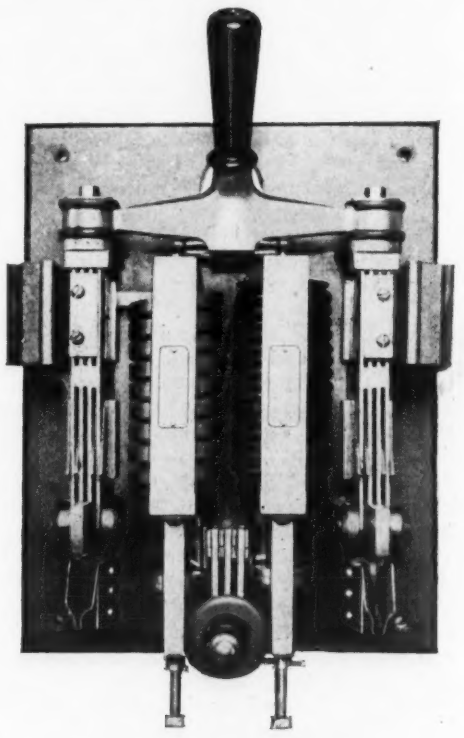


FIG. 3.—WIDE RANGE CIRCUIT BREAKER.

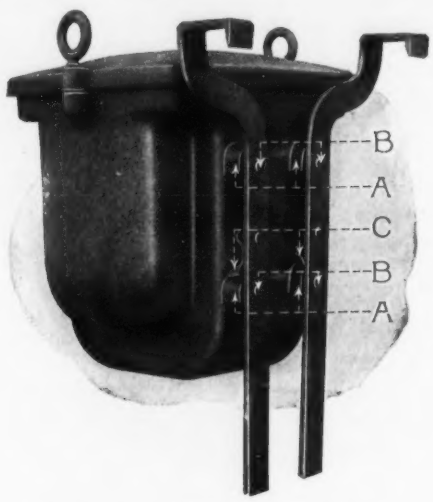
opened by closing a local circuit, either at a point near or at a distance. It is frequently used as a "limit switch" in the circuit of the hoisting motor of cranes, to prevent the hoist block being carried too far. The circuit of the auxiliary coil is arranged to be clesed by the movement of the hoist chain when it reaches the safe limit of its travel.

The growing use of circuit breakers in laboratory work has caused The Cutter Company to design a special type of double-pole circuit breaker having a range of adjustment through two coils, from 25 to 1,000 amperes; a small switch short-circuits the low calibration coil when larger currents are employed than it may safely carry. An instrument of this type is shown in Fig. 3.

Suspension Hook for Transformers.

One of the most annoying incidents attendant on the installation of new for old transformers is the difficulty sometimes experienced in detaching the transformer case from the suspension hooks on the pole or building. This is caused by the rusting of the hook to the case, or in most cases by the rusting of the bolt and nut usually employed to fasten the hook to the case, making it impossible to separate the two without the use of a cold chisel.

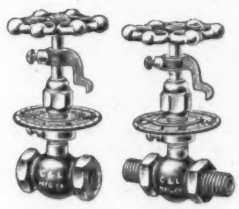
In connection with its new line of oil transformers, the Fort Wayne Electric Works has introduced an effective device, which is especially convenient in application. The illustration shows the ordinary hooks used in mounting the transformer box or cross-arms,



TRANSFORMER SUSPENSION HOOK.

etc., but, instead of separate machine bolts there are riveted studs on the hook shank which engage with the pocket in the lugs and an eccentric cam locking device. These permit the hooks to be readily attached to the transformer before it is elevated to its position; or the hooks can be set in place on the pole and the transformer raised by means of eye-bolts in the case until the pockets *AA* on the back of the case engage with the rivets or studs *BB* on the hanger irons. In either case the eccentric cams *C* can be driven home with a hammer, with just sufficient force to drive the studs well up into the pockets. By this means the transformer is rigidly and strongly attached to the hanger irons, but it is very easy at any time to detach and remove the transformer without disturbing the hooks and without the use of tools.

Dial Needle Point Valves.



NEEDLE-POINT VALVES.

The use of gasoline continues to grow rapidly, and it is now being used to do all manner of work about the house or factory, furnishing heat, light and power. It is a well known fact that ordinary valves suitable for use on water or steam are not suitable for the handling of gasoline. Ground key valves are also of little value, as they do not give proper control of the flow, and soon leak. Fifteen years' experience and an effort to secure the best gasoline fires has enabled the Clayton & Lambert Manufacturing Company, of Detroit, Mich., to make "needle point" valves that are efficient in every way. We illustrate here two new dial needle point valves which they have recently added to their line. By their use a close regulation can be had, so that the flow of gasoline can be controlled. The valves shown are ¼-in. globe and ¼-in. male and male.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Time money was easier and there was more borrowing. The closing rates were 4 per cent. for 30 days to four months, 4¼@4½ per cent. for five and six months. Dulness pervaded the stock market throughout the week, the occurrence of two holidays, Friday and Saturday, checking speculation somewhat. The tone of the market on Thursday, however, was stronger on account of reports of the promised ending of the coal strike. The United States Steel stocks were rather quiet and somewhat heavy on fears that the coal-miners' strike might unfavorably affect the steel industry. Amalgamated Copper was strong and rose to 71¼ on continued favorable reports about the copper situation. Among the outside securities, General Carriage was one of the most active stocks. The announcement that a large majority of General Carriage stockholders had deposited their stock under the plan to subscribe for Manhattan Transit shares by the payment of $2 on each share of the former, caused the old stock to sink to 1⅞, while the stock, assessment paid, brought $2.37 more, or $4.25, thus offering a temporary inducement to shareholders to deposit their holdings. In the traction list Brooklyn Rapid Transit and Metropolitan St. Ry. were both dull, each closing with slight net losses, ⅞ of a point in the former case and 1⅝-points in the latter, the closing prices being 67⅜ and 148⅜, respectively. In the electric list, Westinghouse com. closed at 212, a net loss of 3 points, and Western Union is off ⅜ of a point, the closing quotation being 99¾. Am. Tel. & Tel. closed at 180, making a net gain of 2 points. General Electric was practically neglected during the week, no quotations being established. The closing price on June 2 was 321½, a net gain of 6½ points over the previous quotation. Following are the closing quotations of June 3:

NEW YORK.

	May 27.	June 2.		May 27.	June 2.
American Tel. & Cable.	90	87	Gen. Carriage (n. st'k).	4	4¾
American Tel. & Tel.	176½	176	Hudson River Tel.	—	—
American Dist. Tel.	—	37	Metropolitan St. Ry.	147¾	150
Brooklyn Rapid Transit.	66⅞	68	N. E. Elec. Veh. Trns.	—	—
Commercial Cable	151	169	N. Y. E. V. T. Co.	13¼	13¼
Electric Boat	25	30	N. Y. & N. J. Tel.	—	—
Electric Boat pfd	45	47	Tel. & Tel. Co. Am.	—	—
Electric Lead Reduc'n.	—	3¼	Western Union Tel.	90½	90⅛
Electric Vehicle	7	7	West. E. & M. Co.	212	208
Electric Vehicle pfd	14¾	14	West. E. & M. Co. pfd.	216	210
General Electric	315	321½			

BOSTON.

	May 27.	June 2.		May 27.	June 2.
American Tel. & Tel.	178	175	Mexican Telephone	2¼	2¼
Cumberland Telephone	—	—	New Eng. Telephone	147	147
Edison Elec. Illum.	—	—	Westinghouse Elec.	—	—
Erie Telephone	—	—	Westinghouse Elec. pfd.	—	—
General Electric pfd.	315½	—			

PHILADELPHIA.

	May 27.	June 2.		May 27.	June 2.
American Railways	46	45	Phila. Traction	97¼	97
Elec. Storage Battery.	88	89	Phila. Electric	5¼	5¼
Elec. Storage bat'y pfd.	88	88½	Pa. Elec. Vehicle	—	1¼
Elec. Co. of America.	7	7⅛	Pa. Elec. Vehicle pfd.	—	3

CHICAGO.

	May 27.	June 2.		May 27.	June 2.
Central Union Tel.	—	—	National Carbon pfd.	93	93
Chicago Edison	175⅛	179½	Northwest Elev. com.	37	37¼
Chicago City Ry.	207	205	Union Traction	18⅜	18⅝
Chicago Teleph. Co.	175*	170	Union Traction pfd	52½	52½
National Carbon	24½	24	* Asked.		

WESTERN UNION BONDS.—We are informed, says the *Wall Street Journal,* that several local banking interests are picking up Western Union 4½ per cent. funding and real estate gold bonds at present quotations, believing them a particularly attractive investment with good speculative prospect. In 1900 the issue of $20,000,000 of these bonds was authorized, and of that amount $13,000,000 have been issued bearing the date May 1, 1900, and maturing May, 1950. The bonds are now quoted at 107, making them an income yield of 4.17 per cent. These bonds, which are both coupon and registered, are secured by a first mortgage lien upon all the company's real estate in Chicago and New York, together with all buildings, fixtures and telegraphic equipments thereon, and hold the company's agreement that no future lien or charge shall be created having priority to or preference over the security of this issue or other lien upon its real or personal property without recording a prior lien against the same as security for the payment of the principal and interest of the bonds. The purpose of the issue was to retire $5,681,000 6 and 7 per cent. bonds which matured in 1900, payment of indebtedness incurred from 1895 to June 30, 1900, for new property and new lines, and about $2,000,000 for the physical betterment of the property from June 30 to date. The balance to be used for extension and improvements to be authorized by the directors and the retirement of $1,163,000 7 per cent. real estate bonds which matured this year. The company's outstanding capital stock is $97,340,589, on which 5 per cent. diviends have been regularly paid. It is said that the company will soon begin the construction of 18 new copper circuits between New York and Chicago.

BELL TELEPHONE OUTPUT.—The instrument statement of American Telephone and Telegraph for the month ended May 20 shows:

	1902.	1901.	Changes.	
Gross output	104,661	85,118	Inc.	19,543
Returned	32,441	37,744	Dec.	5,303
Net output	72,220	47,374	Inc.	24,846
From Dec. 20, 1901, to May 20:				
Gross output	492,456	373,623	Inc.	118,833
Returned	184,526	160,348	Inc.	24,178
Net output	307,930	213,275	Inc.	94,655
Total outstanding	2,833,942	2,166,091	Inc.	667,851

AMERICAN STEEL FOUNDRIES.—The announcement of the formation of the American Steel Foundries Company has been made. The six companies which will consolidate are: American Steel Castings Company, of New Jersey; Reliance Steel Castings Co., Limited, of Pittsburg; Leighton & Howard Steel Company, of St. Louis; Franklin Steel Casting Company, of Franklin, Pa.; the Sargent Company, of Chicago, and the American Steel Foundry Company, of St. Louis. The president will be taken from among the officials of United States Steel, and most of the underwriters and promoters, who include Charles M. Schwab, E. H. Bary, Max Pam and others, are closely identified with United States Steel. There will be only $15,000,000 preferred and a similar amount of common stock. The preferred stock will bear 6 per cent. cumulative dividends.

MASSACHUSETTS ELECTRIC.—Stockholders of the Massachusetts Electric Company have held a special meeting to authorize an issue of $5,500,000 preferred stock. Lee, Higginson & Co. and the Old Colony Trust Company offered to purchase as follows: $1,375,000, July 1, 1902, at 93 flat (a 2 per cent. dividend comes off July 1); $1,375,000 on or before October 1, 1902, at 93 and accrued dividend, and $2,750,000 on or before January 1, 1903, at 93 and accrued dividend. The stockholders unanimously voted to sell the stock upon these terms.

MAHONING VALLEY BONDS.—N. W. Harris & Co. offer $1,750,000 first and refunding mortgage 5 per cent. gold bonds of the Pennsylvania and Mahoning Valley Railroad Company, maturing May 1, 1922. The company's system consists of the lines connecting the principal cities and towns in the Mahoning Valley, Ohio, with New Castle and adjacent cities in Pennsylvania, and it owns the entire electric light, power and manufactured gas business of New Castle, Pa.

AMERICAN TELEPHONE.—At a meeting of the directors of the American Telephone and Telegraph Company, held in Boston on May 29, it was voted to issue $21,000,000 of new stock. Stockholders will have the right to subscribe on the basis of one share of new stock for four shares now held. Payments are to be made half in September and one-half in January next.

ELECTRICAL SECURITIES.—Note is made of the listing of the Philadelphia Stock Exchange of $700,000 first mortgage 5 per cent. gold bonds of the Michigan Traction Company. Statement is also made that the $20,000,000 securities of the New Union Electric Light and Power Company of St. Louis will be issued about September 1.

MANHATTAN TRANSIT COMPANY.—A London dispatch refers to a report there that persons identified with the South African syndicate and the London Omnibus Company have bought the control of the Manhattan Transit Company, of New York. The purchasers intend to carry on extensive operations in New York.

NIAGARA POWER.—The stockholders of the Niagara Falls Power Company are voting this week to increase the capital stock of the company from $6,500,000, consisting of 65,000 shares, at the par value of $100 each, to $9,500,000, to consist of 95,000 shares of the par value of $100 each.

NATIONAL CARBON COMPANY is reported to be doing a business this year larger by 20 per cent. than that of last year.

DIVIDEND.—The Chicago City Railway declared a quarterly dividend of 2¼ per cent., payable June 30.

Commercial Intelligence.

THE WEEK IN TRADE.—Trade developments during the week were in the main favorable. The labor situation, particularly in the coal trade, has improved to some extent. General activity still rules among the industries, being especially notable in iron and steel, hardware, lumber, etc. Iron and steel are quieter as regards new business in finished products, but there are reports of large transactions pending in the cruder forms. In finished products, new business is generally small, but the mills are crowded with orders. The gross railway earnings for the third week of May, as indicated by the returns to Bradstreet's, showed an increase over a year ago of nearly 9 per cent. The business failures for the week, as reported by Bradstreet's, numbered 163, as against 152 the previous week, and 144 the same week last year. The copper market was subject to the manipulations of the interests concerned in a new copper company. Early in the week the market showed some strength and prices advanced, but support was withdrawn later, and a distinct weakness prevailed, with lower prices. The closing quotations were 12⅜@12⅝c for Lake, and 12⅛@12.35 for electrolytic. The exports of copper during the week were better than was generally expected, and bring the total for the month to over 13,000 tons.

EXPORTS OF ELECTRICAL MATERIAL.—The following are the exports of electrical materials and machinery from the port of New York for the week just ended: Antwerp—1 pkg. machinery, $75; 9 pkgs. material, $1,063. Argentine Republic—44 pkgs. material, $853. British West Indies—13 pkgs. material, $314; 1 pkg. machinery, $19. Berlin—3 pkgs. material, $105. British Possessions in Africa—474 pkgs. material, $9,737; 39 pkgs. machinery, $1,742. Barcelona—17 pkgs. material, $260. Brazil—33 pkgs. material, $1,353; 3 pkgs. machinery, $900. Bremen—4 pkgs. material, $1,102; 1 pkg. machinery, $75. British East Indies—1 pkg. machinery, $25. British Guiana—37 pkgs. material, $1,069. Cuba—34 pkgs. material, $1,291. Central America—25 pkgs. material, $1,931; 21 pkgs. machinery, $1,785. China—1 pkg. machinery, $1,280; 20 pkgs. material, $1,534. Copenhagen—2 pkgs. material, $191. Chili—75 pkgs. material, $2,894. Glasgow—4 pkgs. material, $371; 1 pkg. machinery, $75. Hamburg—70 pkgs. machinery, $7,665; 13 pkgs. material, $711. Hayti—2 pkgs. material, $29. Havre—28 pkgs. material, $475; 13 pkgs. machinery, $639. Hong Kong—8 pkgs. machinery, $4,650; 13 pkgs. material, $206. Inverness—10 pkgs. machinery, $908. Japan—89 pkgs. material, $6,960; 6 pkgs. machinery, $1,008. Liverpool—151 pkgs. machinery, $11,568; 18 pkgs. material, $439. London—211 pkgs. machinery, $15,073; 162 pkgs. material, $14,009; 15 pkgs. motors and parts, $180. Manchester—7 pkgs. material, $780. Mexico—52 pkgs. material, $1,940; 81 pkgs. machinery, $1,670. Marseilles—1 pkg. machinery, $516. Newcastle—10 pkgs. machinery, $675. Nova Scotia—26 pkgs. material, $380. Newfoundland—4 pkgs. material, $26. Philippine Islands—227 pkgs. material, $5,597. Peru—63 pkgs. material, $2,107. Rotterdam—3 pkgs. machinery, $738; 8 pkgs. material, $110. Southampton—1 pkg. material, $21; 94 pkgs. machinery, $4,872. Siam—54 pkgs. material, $2,200. San Domingo—17 pkgs. material, $268. Uruguay—1 pkg. material, $45. U. S. Colombia—17 pkgs. material, $838; 34 pkgs. machinery, $1,359. Venezuela—57 pkgs. material, $255.

THE CROCKER-WHEELER COMPANY, Ampere, N. J., reports a very satisfactory increase in orders received during the month of May over those for the preceding month. The company is making extensive preparations to accommodate the increasing business, which during the past year has pushed the present shops to their utmost. A new building is under construction, which will enlarge the present floor space by 60,000 square feet, and will be occupied by the winding department, a part of the office force and additional machine shop space. Some of the orders booked during May were: Whitman Mills, New Bedford, Mass, one 200-kw generator; Hanover National Bank, New York, three generators, 100-kw each; American Colortype Company, Chicago, Ill., consignment of 9 motors; Albert Saxe, New York City, two 50-kw and one 75 kw generators; Descubridors Mining and Smelting Company, one 150-kw generator; James McKane, Coney Island, N. Y., one 60-kw generator; Grasser & Brand Brewing Company, Toledo, O., one 75-kw generator and 6 motors; W. H. Wagner & Sons, Freeport, Ill., one 30-kw generator and several motors; J. L. Mitchell, Philadelphia, Pa., one 200-kw generator; Marshall Field & Co., Chicago, Ill., 6 motors, aggregating 150-hp; Naomi Coal Company, Fayette City, Pa., one 110-kw generator; Ingersoll Sargent Drill Company, one 80-kw generator; D'Olier Engineering Company, Philadelphia, Pa., one 100-kw generator; Craig Shipbuilding Company, Toledo, O., two 150-kw generators; Maher & Flockhart, Newark, N. J., one 100-kw generator and one 45-hp motor; Vandergrift Construction Company, Mattewan, N. J., one 200-kw generator; Niles-Bement-Pond Company, Philadelphia, Pa., 50 crane motors, of outputs ranging from 1½ to 50 hp.

ELECTRIC POWER AT GREAT FALLS.—The Boston and Montana Consolidated Copper and Silver Mining Company is making considerable additions to the electrical equipment of its smelters and refineries at Great Falls, Mont., having recently purchased eleven 15-hp and three 40-hp Westinghouse, 500-volt, shunt-wound, direct-current motors. About four years ago this company installed a number of Westinghouse 180-volt, electrolytic generators, and at the same time put in a large number of Westinghouse and other motors for driving ventilating fans and other machinery about the smelters. Although the smelters are filled with sulphur dust and are extremely dirty, the Westinghouse motors have given excellent satisfaction, and the commutators have proved sufficiently insulated between bars to prevent bad grounds.

DENVER POWER AND IRRIGATION COMPANY'S POWER PLANT.—The General Electric Company has secured the contract to furnish the electrical machinery for the extensive power plant to be constructed in Platt Canyon, on the south fork of the Platt River, for the Denver Power and Irrigation Company, of Denver, Colo. These contracts are said to aggregate $350,000. The total cost of the entire system complete and ready for operation will be about $3,000,000, including 28 miles of transmission lines, which will cost about $700,000 alone. The power-house will be double brick and stone structure, 60 x 200 feet in dimensions. The south fork of the Platt River will be dammed at this point.

SUPPLY DEALERS' TRUST.—The Chicago newspapers to hand have a great deal to say about the attack on the Electrical Supply Dealers' Association, made by the independents in that city. It appears that President Burns, of the American Telephone Company, is at the head of the movement, and proposes to make things warm, alleging serious discrimination against concerns outside the "trust." The allegations made are such, it is said, as to bring the organization under the operation of the Sherman Anti-Trust Law, and it is reported that the agitators are taking the necessary steps in the proper legal quarters to set the national machinery in motion.

THE BOSWORTH-HOLDING COMPANY has opened an office and ware-rooms at 26 Merwin Street, Cleveland, O., where it will handle a line of new and second-hand steam and electrical apparatus and machine tools. Mr. W. H. Bosworth, who is well known in the machinery trade, and Mr. H. H. Holding, equally well known in electrical circles, will conduct the business. During the past week the company reports a sale of five carloads of machinery, to parties in Mexico City, Mexico, the purchaser being an iron operator.

ROSSITER, MACGOVERN & COMPANY, New York, have recently bought the greater part of the machinery, including engines and generators, of the One Hundred and Forty-sixth Street (New York) station of the Metropolitan Street Railway Company. Rossiter, MacGovern & Company have also sold to the Boston & Northern Railroad Company and are installing in their station two 850-kw General Electric generators, direct connected to Pennsylvania Iron Works engines.

MICA INSULATION.—A report from Newark, N. J., of May 29, says: The stockholders of the Electric Insulation Company, a New Jersey corporation, backed by New York people, voted to-day to dissolve. The statement was made by L. A. Ziegler, the legal agent of the company, that it had bought a secret process which had turned out a "gold brick." Elijah Woodward, of New York, is president. Further details as to this alleged state of affairs are not forthcoming.

CINCINNATI PLANT.—In the recent article in these pages on the equipment of the Cincinnati Gas and Electric Company, it was stated that the arc lamps of the General Incandescent Arc Light Company are being run off General Electric tub transformers. Such was the information furnished, but we are now advised that the transformers are those of the Wagner Electric Mfg. Co., of St. Louis.

JOHNSON & MORTON, the electrical manufacturers of Utica, N. Y., have opened a New York office at 232-234 Greenwich Street, where they will be represented by Messrs. Frorup & Levy, and where a complete stock will be carried of all their copper panel boards and switches.

CATALOGUES REQUESTED.—Mr. Bert H. Shephard has recently assumed charge of the fixture department from Mr. C. H. Thompson, contractor and dealer in electrical supplies, at Syracuse, N. Y., and makes a request for catalogues, price lists, etc.

THE GARRETT-CROMWELL ENGINEERING COMPANY, Cleveland, O., is preparing plans for a large open hearth steel plant for the Alabama Steel and Wire Company. A large electric power-house will be included in the equipment.

C. J. TOERRING COMPANY, the well-known Philadelphia manufacturers of enclosed arc-lamps, have had to secure more room, and have taken new quarters in the Warden Power Building, Nineteenth Street and Allegheny Avenue.

PAWLING & HARNISCHFEGER, Milwaukee, Wis., makers of electric traveling cranes and hoists, advise us that the condition of business remains entirely satisfactory. The orders recently booked are partly represented as follows: The Falk Company, Milwaukee, one 30-ton, with 5-ton auxiliary hoist; Best Manufacturing Company, Pittsburg, one 2-ton; American Foundry and Construction Company, Hazelwood, Pa., two 10-ton; Fairbanks, Morse & Co., Beloit, Wis., one 15-ton; Warren City Boiler Works, Warren, O., one 10-ton; McClintic-Marshall Construction Company, Pottstown, Pa., one 25-ton; Colorado Fuel and Iron Company, Bessemer, Colo., one 20-ton; Kutztown Foundry and Machine Company, Kutztown, Pa., two 10-ton; Jas. B. Clow & Sons, Chicago, one 3-ton; Modern Steel Structural Company, Waukesha, Wis., one 15-ton; Nordberg Manufacturing Company, Milwaukee, one 2-ton jib; Pennsylvania Railroad Company, Altoona, Pa., two 12½-ton; the Chapman Valve Manufacturing Company, Indian Orchard, Mass., one 20-ton, with 2-ton auxiliary hoist; the Milwaukee Electric Railway and Light Company, Milwaukee, one 30-ton; Warren Steam Pump Company, Warren, Mass., one 15-ton; Allis-Chalmers Company., Edw. P. Allis Works, West Allis, Wis., two 5-ton wall, and one 2½-ton wall; the Lodge & Shipley Machine Tool Company, Cincinnati, O., one 12-ton; American Bridge Company, Pencoyd plant, Pa., one 25-ton; Baldwin Locomotive Works, Philadelphia, six 10-ton; Gardner Governor Company, Quincy, Ill., one 5-ton; American Sheet Steel Company, Scottdale Works, Scottdale, Pa., two 5-ton specials; the Stilwell-Bierce & Smith-Vaile Company, Dayton,O., two 20-ton, two 10-ton, four 5-ton; the Bucyrus Company, South Milwaukee, one 3-ton; Midvale Steel Company, Philadelphia, one 10-ton.

SOME LIDGERWOOD HOIST CONTRACTS.—The Lidgerwood Manufacturing Company, 96 Liberty Street, New York, have recently been awarded several orders for electric hoisting equipments for shipment to various parts of the world. The United Engineering Company, of Johannesburg, has requisitioned for three double-drum hoists, each of which are to be operated by 25-hp motors built by the General Electric Company. These equipments are intended to be utilized in South African mines. The General Electric Company has ordered three hoists for the English market, which will be driven by General Electric motors of 25-hp. The same concern has also placed orders with the Lidgerwood Company for 10 hoisting equipments for the domestic market. These machines will be worked with General Electric motors, varying from 10 to 100 hp. Contracts for the American market lately taken by the Lidgerwood people include one for 10 double-drum machines, to be operated by General Electric motors of 25-hp each. This contract was placed by Norcross Brothers. The hoists will be used in the building operations of the new library, at Forty-second Street and Fifth Avenue, New York. The Columbus Construction Company, of Weston, Mass., have called for a double drum equipment, to be driven by a 25-hp General Electric motor. The New York Dock Company has ordered three single and one double equipment, each for direct connection to 25-hp General Electric motors. The Lackawanna Iron and Steel Company, of Buffalo, N. Y., is to be supplied with three double drum hoists, to be operated by 50 hp General Electric motors, and the Union Pacific shops at Omaha, Neb., will be equipped with a single drum electric hoist, to be driven by a 50-hp General Electric motor.

VARIOUS HARRISBURG ENGINE ORDERS.—The Harrisburg Foundry and Machine Works, of Harrisburg, Pa., have been awarded a contract for furnishing a 300-hp tandem compound standard engine, which is to be direct connected to a 200-kw generator built by the Crocker-Wheeler Company for installation for power purposes at the latter concern's works at Ampere, N. J. One 225-hp, one 150-hp and one 120-hp standard simple engines are to be installed in the new apartment house now under construction by the Thompson-Starrett Company in Sixty-seventh Street, New York. The engines will be direct connected to 150-kw, 100-kw and 75-kw General Electric generators, respectively. These equipments will be utilized for both light and power purposes. The Mergenthaler Linotype Company has ordered a 300-hp tandem compound standard engine for direct connection to a 200-kw Sprague generator for power uses at its Brooklyn plant. For light purposes three 75-hp standard simple engines, direct connected to 50-kw generators, manufactured by the General Electric Company, are to be installed in the new Pennsylvania Building, Philadelphia. A 120-hp, also a 75-hp, standard simple engine have been ordered for light and power use in the new Childs Building on Thirty-seventh Street, New York. The engines will be direct connected to 75-kw and 50-kw General Electric generators. The Webster Coal and Coke Company, of Ehrenfeld, Pa., has ordered a 300-hp simple standard engine for direct connection to a 200-kw generator, built by the General Electric Company. This equipment will serve for power purposes in the Pennsylvania plant.

SHAW CRANES FOR P. R. R. SHOPS.—Manning, Maxwell & Moore, of 85-89 Liberty Street, New York, have just closed a substantial contract for the supply of four electric traveling cranes to the Pennsylvania Railroad Company. Two cranes of 75-ton capacity each are to be installed in the new shops of the company, at Columbus, O. They will be operated by 5 motors each, having an aggregate capacity of 325 hp. Two 6.5-ton cranes have also been ordered for installation in the railroad shops about to be constructed at Renovo, Pa. They will each be driven by motors having a total capacity of 300-hp. The span in both shops is to be 74 feet 5 inches, and each crane is provided with two 7½-ton auxiliary hoists. The value of the contract exceeds $60,000.

HUGE SHIPMENTS OF EQUIPMENT FOR BRITISH WESTINGHOUSE COMPANY.—Over two and a quarter millions of dollars' worth of electrical equipment and various machinery have been shipped so far this year to England on behalf of the British Westinghouse Electric and Manufacturing Company, Limited, the major portion of which will serve as equipment for the company's new plant now all but completed at Trafford Park. The machinery bought in the open market here for the British plant, consisting principally of a $500,000 lot of the most up-to-date machine tools, has already been forwarded to the other side. Besides the company's purchases from different machinery concerns throughout the United States, it is calculated that the Westinghouse shops at Pittsburg have shipped fully a half a million dollars' worth of engines and various electrical equipments for the Manchester plant. The total expenditure in the way of American equipment for the British works will, it is now reported, exceed $1,500,000. Each of the next four Lambert & Holt steamers leaving this port for Manchester will carry over $50,000 worth of different machinery for the British Westinghouse works. To help fulfil contracts awarded to the British company, a round $1,000,000 worth of various electrical equipment has been shipped within the past five months from this side—chiefly from the Westinghouse plants at East Pittsburg.

WESTINGHOUSE TURBINE AND MOTOR ORDERS.—Westinghouse, Church, Kerr & Company have obtained a contract from the Wilmington, N. C., Gas and Light Company, calling for a 400-kw Westinghouse steam turbine unit with an alternating-current generator. J. K. Robinson, of Iquique, Chili, who represents the Westinghouse interests on the west coast of South America, and who is now in the United States and can be found at the offices of the William E. Peck Company, 100 William Street, New York, has ordered several Westinghouse multipolar direct-current motors of various sizes, for use in the Chilian nitrate fields.

BOOK TYPEWRITERS FOR ABROAD.—The Elliott & Hatch Book Typewriter Company, 256 Broadway, New York City, has, within the last few days, received contracts for book typewriting machines, to be forwarded to Germany, for use in the govermnent railway offices; to the Philippines, for the military authorities, and to Mexico, for utilization in the various departmentss of the government of the Southern Republic. The company also reports receipt of substantial orders from Canadian sources and from the Illinois Central, the Michigan Central and the Pennsylvania railroad companies.

MORE MEXICAN WATER-POWER PROJECTS.—The Jalapa Railway and Power Company, Jalapa, State of Vera Cruz, Mexico, which derives its power from the Falls of Teocelo, is about to increase its plant for the purpose of furnishing the City of Vera Cruz, some 40 miles distant, with current. Alexander Kinnell, of the latter city, has been granted a concession for utilizing the waters of the Antigua River, near Jalapa, up to 40,000 liters per second, for a distance of about 80 miles, for motive power.

COAL FOR PORTO RICO PLANT.—The San Juan Light and Transit Company, of San Juan, Porto Rico, whose system was constructed by J. G. White & Company, has recently been shipped some 1,500 tons of Pocohontas coal for its power plant, and has just given an order for a similar cargo, which will be forwarded within the next few days, from Norfolk, Va.

PLANT FOR WEST TAMPA, FLA.—An electric power plant will be installed by the city of West Tampa, Fla. The Ball Engine Company, Erie, Pa., furnishes the complete steam plant. The generator will be furnished by the Westinghouse Electric and Manufacturing Company.

CRANE PIPE SHIPMENT FOR SOUTH AFRICA.—The Crane Company, of Chicago, Ill., has made shipment of 10 carloads of pipe, etc., to the South African port of East London. The material is intended to be eventually forwarded to Johannesburg.

POWER APPARATUS WANTED.—The Maumee, O., Electric Company is in the market for new turbines, gearing, shafting, pulleys and floor stands. D. W. Tryon is president, N. E. Tryon, vice president and A. C. Tryon, secretary and treasurer.

CALL & COMBS, of Wilkesboro, N. C., are moving their insulator pin factory, and are making considerable improvement in their plant. As soon as settled, they will be in a better position than ever to fill orders promptly.

General News.

THE TELEPHONE.

BIRMINGHAM, ALA.—The Board of Trade of Birmingham has passed resolutions denouncing the present telephone service as unsatisfactory, and a committee has been appointed to investigate the matter and suggest remedies.

DENVER, COLO.—The Colorado Telephone Company will furnish the city with 75 telephones free. The consideration asked was that the city use the telephones of no other company during the life of the company's franchise.

OLIVER, GA.—The Oliver Telephone Company will soon complete its line to Halcyondale. It will then be extended to Hugginsville.

COLUMBUS, GA.—A petition for a telephone franchise has been presented to the city council. The proposed system will be connected with a number of other independent systems throughout Georgia.

DECATUR, GA.—The Southern Bell Telephone Company has for many months been trying to secure an extension of franchises from both towns without success. Several propositions have been made and rejected either by the cities or the company. Several other companies are negotiating for franchises.

PEORIA, ILL.—The Interstate Telephone & Telegraph Company has received permission to construct its underground conduit plant.

MOUNT VERNON, ILL.—The Talbot-Frost Telephone Company has been incorporated with a capital stock of $2,500. S. T. Maxey is president, C. B. Boots, secretary, and M. A. Barber, Treasurer.

SPARTA, ILLS.—The Gordon Telephone Company has completed its long-distance line to Sparta, and is now preparing to lay a cable from Chester to the Missouri shore, when connection will be made by the Bell system with a large number of permanent towns.

VALPARAISO, IND.—The Northwestern Indiana Telephone Company, of this city, has increased its capital stock to $15,000.

ELWOOD, IND.—The new telephone company of this city expects to have its exchange ready and all wires up in shape for business by July 1.

PORTLAND, IND.—A telephone war at this place has been avoided by the Home Telephone Company buying the exchange owned by the United Company, of Bluffton.

TERRE HAUTE, IND.—The Citizens' Telephone Company, which now has nearly one thousand city subscribers, has made connection at the Illinois line with the system of the independent company lines in central Illinois.

ELKHART, IND.—The Home Telephone Company expects to have communication with the independent company of South Bend within sixty days. The Home Company is to build to the county line to meet the South Bend company's extension.

SHELBYVILLE, IND.—The Central Union Telephone Company has completed extensive improvements in this city and has added 21 new connections. The company has also begun rural development, and will soon take in a score of neighboring towns.

INDIANAPOLIS, IND.—The Eureka Telephone Company, of Titus, capital stock, $10,000; the Pleva Home Telephone Company, of Pleva, capital stock, $5,000, and the Daviess County Home Telephone Company, of Washington, capital stock, $100,000, have been incorporated.

INDIANAPOLIS, IND.—The following telephone companies were incorporated recently; the West Newton Telephone Company, of West Newton, capital stock, $10,000; the Frost Telephone Company, of Hancock county, capital stock, $1,200; and the Shirley Telephone Company, of Shirley, capital stock, $3,000.

CRESTON, IA.—Wm. Bowen, of Des Moines, and the Farmers' Mutual Telephone Company have been granted telephone franchises in Red Oak.

SHENANDOAH, IA.—A special election will be held here on June 28 to vote on the question of granting a franchise to the Independent Mutual Telephone Company.

PORTLAND, ME.—The People's Telephone & Telegraph Company has been incorporated at Kittery with a capital of $500,000. Hammond Braman, of Boston, is president, and F. E. Baldwin, of Boston, treasurer.

BAY VIEW, MICH.—A mass meeting was held here recently and plans made for an independent telephone system.

MILFORD, MICH.—A Michigan telephone solicitor is canvassing the town for a new exchange, and has secured contracts for 45 telephones.

MUSKEGON, MICH.—The Citizens' Telephone Company here is making an addition to its switchboard, accommodating 300 new subscribers.

ALBION, MICH.—The business men's committee has announced that nearly 300 subscribers have been secured for the proposed independent telephone company, and that as soon as that number has been reached the company will be organized and the exchange built.

CENTRAL LAKE, MICH.—Telephone service for the farmers of this vicinty is a possibility in the near future. The manager of the local exchange of the Michigan Telephone Company is planning to enlarge the exchange and connect farmers within a greater or less radius of the village.

LUDINGTON, MICH.—The Michigan Telephone Company is at work among the farmers of Mason county, and a large number of them have been connected with the Ludington exchange within the last few weeks. As soon as the weather becomes settled the company will hang 2,300 feet of new cable in this town.

JACKSON, MICH.—The Jackson Telephone Company, which has recently been acquired by local parties, has placed a contract with the Kellogg Switchboard & Supply Company, of Chicago, for a multiple central energy switchboard of 3,600 ultimate capacity. It is expected the exchange, with 2,000 telephones, will be placed in operation in the fall.

SPARTA, MICH.—Manager Bolander, of the local Independent Telephone Company, has been in conference with the officers of the Citizens' Telephone Company, of Grand Rapids, in reference to the absorption of the local company by the larger one, and the arrangement, which is in the interest of better service here, will very likely be consummated within a few weeks.

BEAR LAKE, MICH.—The Benzie County Telephone Company has arranged for the construction of a number of copper circuits to nearby towns and villages, and plans to make this town a central telephone point for the county of Manistee. Farmers throughout this part of the county are now being connected with the exchange and thus with the merchants of Bear Lake, with whom they are doing business, as well as with the independent systems of the State. Forty business men and farmers of Benzie and Manistee counties comprise the company.

SAULT STE. MARIE, MICH.—A war is on between the Michigan Telephone Company and the common council here. The company refused to place a telephone in the new water works plant on the ground that it would cost $500 to make the extension. The franchise provision requiring the company to furnish the city with all telephones ordered was pointed out, but the company retorted that it was not operating under that franchise but under one secured by purchase of the Citizens' Company. The council thereupon repealed and annulled all telephone franchises and ordinances, and so the merry war goes on.

GRAND RAPIDS, MICH.—The number of subscribers to the Michigan Telephone Company's system in this city has steadily decreased since Jan. 1, when the rates were advanced. This is admitted, and is ascribed to the advance in rates. The service at the exchange is the very best, and the most improved form of lamp signal switchboard is in use. The company's new substations, of which there are two, are not yet occupied, although they have been completed for some months, and it is explained that this is because action on the part of the new company in control, the Western Telephone Company, is awaited. There is a strong sentiment in this city in favor of the independent telephone company, the stock of which is held locally, and this sentiment appears to be steadily growing. The local retail grocers' association and the organized meat dealers have taken up the matter of using but one telephone and discarding the other and while no formal action has been taken as yet, the independent company is the favorite. There appears to be a strong wave of independent telephone sentiment moving over the State at present.

MINNEAPOLIS, MINN.—The Bell Telephone will construct a line south from Winnipeg.

RENO, NEV.—The Sunset Telephone Company expects to spend $8,000 on improvements to the telephone system in Reno.

EAST AURORA, N. Y.—The Haines Telephone Company, of Buffalo, has been granted a franchise in this place.

GOLDSBORO, N. C.—A petition has been asked for a franchise for the Southern Bell Telephone Company, at Goldsboro.

GREENSBORO, N. C.—The Southern Bell Telephone & Telegraph Company has made application for a franchise for a local exchange in this place.

WILMINGTON, N. C.—The Southern Bell Telephone Company will extend its service to Carolina Beach this summer for the convenience of city patrons.

TARBORO, N. C.—The Carolina Telegraph & Telephone Company has bought the Dunn and Smithfield exchanges, with their toll lines, and a new copper line will be built from Salem to Raleigh, N. C.

DEMOCRAT, N. C.—The Ivy Telephone Company, of Democrat, has eighteen miles of line running from Mars Hill to Stocksville. Its aim is to get connections with Asheville as soon as possible and also with Cane River.

PITTSBORO, N. C.—The stockholders of the Chatham Telephone Company have elected Mr. B. M. Poe as president and business manager. The company will establish an exchange in Pittsboro, and extend its system to Bynum, five miles north.

WILMINGTON, N. C.—The desired franchise has been granted at Wilmington to the Telephone Company of America, with some modifications protecting the city from loss and with an amendment whereby not more than one cent can be charged for each coll.

LEBANON, OHIO.—The Central Union Telephone Company has been granted a franchise to maintain a system in the town.

BEREA, OHIO.—The Citizens' Telephone Company has increased its capital stock from $20,000 to $40,000, to provide for improvements.

TROY, OHIO.—The Troy Telephone Company is installing a new switchboard. Indications are that 1,000 telephones will be in service this summer.

GARRETTSVILLE, OHIO.—The Garrettsville Telephone Company has 127 subscribers, and is building farmers' lines, which will increase its capacity considerably.

ALLIANCE, OHIO.—The Alliance exchange of the Stark County Telephone Company was opened to the public a few evenings ago. Several hundred people attended the reception.

CANTON, OHIO.—The Central Union Telephone Company has changed its Cleveland rate from 40 cents for three minutes to 25 cents for one minute and 5 cents for each additional minute.

ADA, OHIO.—A. A. Geiger has been elected secretary and director of the Ada Telephone Company. Mr. Geiger was formerly in charge of construction work for the Norwalk & Huron County Telephone Company.

AKRON, OHIO.—The statement of the Akron People's Telephone Company for the first quarter of 1902 follows: Gross earnings, $16,195; expenses and taxes, $7,465; net earnings, $8,730; interest, $3,644; surplus, $5,086.

ELYRIA, OHIO.—The Elyria Telephone Company will increase its capital stock from $20,000 to $40,000. This was made necessary to take care of the additional service required. The company will increase its rates at once.

MANSFIELD, OHIO.—I. S. Hoffman and J. P. Rummel, general manager and contract manager respectively of the local Bell Company, have accepted similar positions with the Mansfield Telephone Company, the new independent company.

UPPER SANDUSKY, OHIO.—The Upper Sandusky Telephone Company has increased its capital stock to $30,000, and has sold part of the stock to leading local business men. The company has 400 subscribers connected up, and it is growing rapidly.

PORTSMOUTH, OHIO.—The statement of the Portsmouth Telephone Company for the first quarter of 1902 follows: Gross earnings, $4,569; expenses and taxes, $2,697; interest, $874; surplus, $999. The company has about 920 telephones in operation.

XENIA, OHIO.—H. C. Dean, of Jamestown, has been appointed manager of the lines of the Springfield-Xenia Telephone Company in Greene county. The company has about 1,000 subscribers in the county, and is contemplating building a number of farmers' lines.

COLUMBUS, OHIO.—The statement of the Columbus Citizens' Telephone Company for the first quarter of 1902 follows: Gross earnings, $44,296; expenses and taxes, $27,752; net earnings, $16,645; interest, $8,125; surplus, $8,519. The company has about 5,975 telephones in operation.

TOLEDO, OHIO.—The Central Union Telephone Company is preparing for the competition of the new independent company by reducing its rates. The residence rates have been dropped from $48 to $36 per year, and it is stated that there will be a corresponding drop in the business rates. This is for full metallic service.

WEST UNITY, OHIO.—The Stryker Telephone Company has acquired the franchise granted some time ago to the Williams County Toll Line Company and will operate under it. Contract has been placed with the Northwestern Construction Company, of Bryan, to build and equip the lines in this town and throughout the surrounding country.

CLEVELAND, OHIO.—The bankers' committee, in charge of Everett-Moore affairs, has arranged for the disposal of the exchanges at Jackson, Mich., and Galion, O. The Jackson exchange will be completed by a syndicate composed of Jackson parties, who will advance $70,000 for the purpose, placing the exchange on an earning basis. The exchange at Galion has been sold outright to Galion and Bellevue parties.

CLEVELAND, OHIO.—The report of the earnings of the Cuyahoga Telephone Company for the first quarter of the year shows net earnings of over $4,000, or over $50,000 per annum after taking care of all fixed charges. The gross earnings for January, February and March, 1902, were respectively: $30,252.51, $30,352.46 and $31,757.78. The total expenses and taxes were: $16,258.68, $16,799 and $18,218.66. The net earnings were: $13,993.83, $13,552.87 and $13,589.12. Total deductions for interest and bonds and ground rent: $9,512.51, $9,512.49 and $9,512.49. The surplus was, $4,481.32, $4,040.38 and $4,026.63.

COLUMBIA, S. C.—The Consolidated Telephone Company, of Columbia, has been chartered preparatory to commencing business in this city.

COLUMBIA, S. C.—According to the last report of the State Corporation Commission, there are 70 incorporated telephone companies in the State, operating 5,193 business telephones and 5,739 residence instruments.

COLUMBIA, S. C.—The South Carolina Long Distance Telephone Company has completed its line toward Augusta by connecting with an independent line out from that city, thus establishing communication between Columbia and Augusta.

COLUMBUS, S. C.—Mr. S. L. Miller, of the Independent Telephone Company, states that there are now in South Carolina two independent telephones to one of the Bell Company. He states that by the end of the year there will be three to one.

McMINNVILLE, TENN.—The Citizens' Telephone Company has been recently organized here and is pushing construction work. The poles are all erected, and the stringing of wires is rapidly going forward.

SALT LAKE CITY, UTAH.—The Rocky Mountain Bell Telephone Company will at once begin on the Thunder Mountain line, following the Boise-Thunder Mountain road, starting from Boise, Idaho.

PROVO, UTAH.—The Telluride Power Company, of Provo, has applied to the Salt Lake county commissioners for a franchise to operate a telephone system in the county. It is reported that this move is a part of the Jones-Fenton scheme to do a suburban business.

SALT LAKE CITY, UTAH.—The Rocky Mountain Bell Telephone Company has issued an order that all telephone operators in the Missoula (Mont.) exchange must learn telegraphy. The company will arrange the long distance lines so that they can be used either for telephoning or telegraphing.

SALT LAKE CITY, UTAH.—Exchanges will be soon installed by the Rocky Mountain Bell Telephone Company at Billings, Bridger, Boulder, Fort Benton, Sheridan and Virginia City, Mont. In Utah work has started on exchanges at Beaver, Milford and Payson, and an extension of the toll line south from Beaver, Parawan, Cedar City, Washington and St. George will be soon connected with the general telephone system.

GLOUCESTER, VA.—The Board of Directors of the Tidewater Telephone Company decided to accept the offer of the Citizens' Company, of Newport News, to connect with the company's exchange at Gloucester.

SPRAGUE, WASH.—The Farmers' Telephone Company has been organized at Sprague, with a capital of $5,000. About 75 miles of line will be built.

SPOKANE, WASH.—The Spokane city council has turned down the application for a franchise for a second telephone company to do business in Spokane, on the ground that the people consider that one telephone company is enough for the town.

MILWAUKEE, WIS.—The Milwaukee Independent Telephone Company has incorporated with a capital stock of $50,000. E. Reynolds and others are interested.

ELECTRIC LIGHT AND POWER.

SAN FRANCISCO, CALIF.—The Oregon General Electric Company has secured the control of a piece of property on the upper Clackamas river, near the site of the company's power house, which is in course of construction. Power will be generated for railway and lighting purposes.

SAN FRANCISCO, CALIF.—An electric power plant, which will transmit current to Ukiah, Calif., will be installed by O. E. Williams and associates. They expect to build a dam near the mouth of Cold Creek, whence the water will be piped 3 miles to the power station, which will be erected at the mill site.

SAN FRANCISCO, CALIF.—The Pioneer Mill Company, of Honolulu, H. T., has closed contracts with Grimwood, Richardson & Holloway for the installation of an electric power plant, which will use water from the streams in the mountains near Lahaina. The contract price is placed at $35,000. Additional plants will be installed later on.

SAN FRANCISCO, CALIF.—The General Electric Company has closed a contract with the American Steel & Wire Company for a number of induction motors, aggregating 400-hp in capacity, for its new plant in San Francisco. These are slow speed motors, several being direct connecteed to machines. Those that are not direct connected will be placed on the ceiling.

SAN FRANCISCO, CALIF.—Alum Rock Park, eight miles from San Jose, Calif., is now lighted by electricity, supplied from the power station of the electric railway. The Santa Clara & Alum Rock Railroad was recently changed over to electric power. Remarkable spectacular effects are produced by the lights in the natural park with its picturesque canyon.

SAN FRANCISCO, CALIF.—The Standard Electric Company is improving its great Bear river dam in Amador County, Calif. A great deal of hydraulic work will be done in the future on the company's storage reservoirs, although there is ample capacity for the present necessities. The new plant at Electa is now in operation, transmitting current to San Francisco and way points.

SAN FRANCISCO, CALIF.—The Colorado Pacific Gold Dredging Company is building a dredger costing $60,000, and remodelling an old one for electric power at Mississippi Bar. The Syndicate Dredging Company is also building a $60,000 Risdon dredger for use near Teat's Flat. Electric power for the operation of these dredges will be supplied from the transmission lines of the Sacramento Electric, Gas & Railway Company.

SAN FRANCISCO, CALIF.—The Mt. Whitney Power Company, which transmits current to Visalia, Calif., is doing hydraulic work for the auxiliary plant which is to be constructed on the middle fork of the Kaweah river one mile west of the present power station. Near Sequoia Park 2,000 inches of water will be diverted and conducted 4½ miles to a point where there will be a working head of 325 feet, giving a capacity of over 1,000 hp. The growing demand for motor pumping for irrigating citrus fruit land necessitates an increase of the company's generating capacity. The new plant will probably be completed this summer.

SAN FRANCISCO, CALIF.—The San Francisco Gas & Electric Company has closed a contract with the General Electric Company for two additional 1,250 kw direct connected 3-phase generators and five 250 kw motor-generator sets. Switchboards and other appurtenances are included. A Union Iron Works engine of about 1,600-hp will be direct connected to each generator. The motor-generators will be operated as synchronous motors at 4,150 volts, which is the voltage of the generators, therefore no transformers will be required. It is understood that contracts have been closed for about 1,800 hp of Heine boilers, through the Risdon Iron Works. The new apparatus will be installed at the Gas & Electric Company's arc and alternating station on Townsend street. The first unit will be installed before the close of this year.

SAN FRANCISCO, CALIF.—The Stanislaus Water & Power Company, a new San Francisco corporation, capitalized at $2,500,000, is planning to install an electric transmission system at an expense of $2,000,000. It is proposed to transmit 20,000 hp to San Francisco and intermediate points from the plant which will be located in Calaveras county, about 6 miles from Murphy's. An inverted syphon will carry 6,000 inches of water across a canyon which has almost vertical walls 1,500 feet in height. Two lines of steel pipe 30 inches in diameter will conduct the water down one side of the canyon and up the other. At the power plant there will be an available head of 1,500 feet, which, with 7,000 inches of water, will develop about 21,000 hp. The mining regions of Central Hill, Cataract Channel and the San Domingo property will have the use of electric power and water from the system. W. Frank Pierce, president of the Standard Electric Company, and H. G. Veder, the Pittsburg capitalist, are connected with the new concern, which has ample backing and business prospects.

BOULDER, COLO.—The Boulder Railway & Utility Company and the Boulder Light & Power Company are about to consolidate.

ALAMOSA, COLO.—The Alamosa Electric Light Company has awarded the contract for the erection of the entire works to the Gilbert-Wilkes Electrical Company, of Denver.

TALLAHASSEE, FLA.—The Tampa Municipal and West Coast Development Company has been chartered at Tallahassee with $1,000,000 capital to operate railways, electric light plants, telephone lines, etc.

ALBION, IDAHO.—The electric light plant here is to be closed temporarily on account of not paying expenses. This is a private company.

WEISER, IDAHO.—The city council has granted to H. V. Gates, of Hillsboro, Ore., a franchise to install an electric lighting plant. The city is to own the plant, giving Mr. Gates a lease for 15 years at $1.00 per year rental. The city will vote $25,000 in bonds for the plant.

UPLAND, IND.—Steps have been taken by the town board to put in an electric light system for this place.

SEYMOUR, IND.—The Seymour Electric Light Company has been organized. The capital stock is $75,000. John H. Brown is president.

EVANSVILLE, IND.—The property and franchise of the Evansville Electric Light Company passed into the hands of Farson, Leach & Co., brokers, of Chicago.

CRAWFORDSVILLE, IND.—The municipal electric light plant of this city is proving a failure. The cost of municipal lighting is so great as to cause the people to complain.

RICHMOND, IND.—It is now to be a war to the finish between the Richmond municipal electric light plant and the local Light, Heat & Power Company. The old company has cut its rate in two, making them slightly lower than the rates fixed by the council for the municipal plant.

VINCENNES, IND.—The city council has passed, over the mayor's veto, an ordinance granting a 30-year franchise to J. L. Bayard and others to erect and operate an electric light, power and heating plant in the city; and also the right to consolidate with any concern that may hereafter put in a plant.

ENFIELD, MASS.—The Mill River Electric Light Company has been organized at Williamsburg. It will build a power house and supply light to Williamsburg and Haydenville.

SOUTH HAVEN, MICH.—The South Haven Fuel, Light & Power Company will build a $40,000 electric plant. A. C. Runyon is president of the company, and Bascom Parker, Niles, Mich., is engineer.

ST. LOUIS, MO.—The Missouri & Meramec Water Company is asking permission to construct a canal between the Missouri and Meramec rivers for furnishing power for manufacturing purposes.

ST. LOUIS, MO.—The Union Electric Light & Power Company, with a capital stock of $20,000,000, will be the successor of the four merged electric light companies. The Imperial Lighting, Heat and Power Company, the City Lighting Company, the Seckner Construction Company and the Citizens' Electric Lighting & Power Company are the four companies concerned. It is stated that Mr. Julius S. Walsh will be president. The plan laid before the stockholders calls for an issue of $10,000,000 in bonds and $10,000,000 in stock. The bonds will bear 5 per cent. interest. The preferred stock will amount to about $2,000,000, and will also bear 5 per cent. interest. It is stated that at the outset only $4,000,000 of the issue will be used. The effect of the consolidation will put three powerful lighting corporations in the St. Louis field. The two rivals are the Missouri-Edison Company and the Laclede Gas Light Company. It has been predicted that eventually all these interests will unite. The Citizens' plant, at the foot of Ashley street, will, when finished, be one of the largest in the west. Immense buildings are under construction, though strikes and injunctions growing out of a difficulty with the city about taking water direct from the Mississippi river have delayed work greatly. The present plans call for an expenditure of $2,000,000 on the Citizens' plant, and this will be increased. The company made a contract with the World's Fair Company to supply electric light and power for the Fair, and this will require a vast outlay for machinery, orders for which must be placed months in advance. The Citizens' Company has its wires in the conduit district, between Beach street and Clark avenue and east of Jefferson avenue, and is now supplying all customers in the business district. The Imperial is already operating in this territory, but not beyond. Back of this big deal besides St. Louis capital are the interests represented in the North American Company.

BILLINGS, MONT.—The meetings of the Citizens' Electric Company, of Billings, elected officers for the ensuing year as follows: C. Yegen, president; L. H. Tenske, vice-president; J. E. Kurtz, secretary.

HELENA, MONT.—The street railway, electric light and gas plants of the Helena Power & Light Company were sold at auction on May 20. T. A. Marlow, representing a number of Eastern capitalists, was the only bidder, his offer being $200,000, which was accepted. The new owners will make extensive improvements to the plant, also extend the street railway.

CARSON CITY, NEV.—Articles of incorporation of the Nevada Construction Company have been filed at Carson City. Capital, $100,000. W. E. Sharon, C. A. Lux, J. N. Gardiner are the incorporators. The objects of the company include the installation of electric power and electric light plants for mining camps.

ALBUQUERQUE, NEW MEX.—The New Mexico Light & Power Company has been incorporated in New Mexico with a capital stock of $50,000, by C. D. Cochrane, of Boston, and E. L. Medley, of Albuquerque.

ALBANY, N. Y.—The Queens' Borough Gas & Electric Company, of Queens county, has been incorporated with a capital of $2,000,000. The directors are John L. Lockwood, Jr.; H. Julian R. Lockwood, Frederick P. Delafield, Lewis D. Delafield and Thomas Ferry, of New York, and John Joseph Reedy and Charles E. Wilson, of Jersey City.

ALBANY, N. Y.—The Union Gas & Electric Company, with a capital stock of $2,000,000, has been incorporated to operate in New York city, counties of New York, Queens and Nassau, town of Hempstead and the villages of Freeport, Rockville Centre, Lawrence and East Rockaway. The directors are John L. Lockwood, Jr., H. Julian R. Lockwood, Frederick P. Delafield and Lewis L. Delafield, of New York City; John Joseph Boody and Charles E. Wilson, of Jersey City, and H. Thomas Ferry, of Tomkinsville.

MADISONVILLE, OHIO.—The village lighting plant was damaged by fire recently. New machinery which was being installed was damaged slightly.

EAST LIVERPOOL, OHIO.—Harry Boals, of Salineville, has the contract for installing an electric light and power plant in the new sewer pipe works at Irondale, Ohio.

TOLEDO, OHIO.—A. B. Sturgis, of Toledo, is preparing plans for the St. Paul Building, to be erected in this city. An electric lighting plant and material will be required.

KENTON, OHIO.—The Kenton Gas & Electric Company is installing a new 250-hp engine, and will shortly add to its boiler capacity. A 2,400-light generator was recently installed.

COALTON, OHIO.—The Coalton Light & Power Company, capital stock $7,000, has been incorporated by W. D. Hoppel, J. H. Ray, Wm. Rickabaugh, G. M. Scott and H. W. Ray.

COLUMBUS, OHIO.—The Central Heating & Lighting Company is endeavoring to secure a general franchise permitting it to extend its heating and lighting service throughout the city.

COLUMBUS, OHIO.—Stribling & Lum are preparing plans for an electric lighting plant, to be installed at the State Institution for the Blind at Columbus. New boilers will also be installed.

EAST LIVERPOOL, OHIO.—The Ceramic City Light Company is endeavoring to induce customers to sign a yearly contract for current at 15 cents per kw-hour. The minimum rate is 60 cents per month.

COLUMBUS, OHIO.—John D. Karns, representing the Citizens' Heating & Lighting Company, has applied for a franchise to furnish electric light and steam heat in the residence portion of the city. The company will incorporate with $300,000 if it gets the franchise.

CAREY, OHIO.—Municipal ownership is proving satisfactory in this place. Last year the total income from the lighting and waterworks plant was $11,458 and the expenditures $9,805. The outstanding liabilities are $29,000. Formerly the town paid $1,000 per year for illumination.

CLEVELAND, OHIO.—The Cleveland Electric Illuminating Company is using three Baker electric vehicles in renewing carbons in the business section of the city. The vehicles average between 40 and 50 miles per day, and are giving excellent service. They were designed especially for the work, having large battery capacity.

CLEVELAND, OHIO.—George S. Ryder & Company, Cleveland engineers, have completed the installation of a power plant for the American Crayon Company, Sandusky, Ohio. It consists of a 200-kw Westinghouse 2-phase alternating current generator, a 400-hp Allis-Chalmers engine and Erie City tubular boilers. The firm is preparing plans for several power plants in the vicinity of Cleveland.

NEW LEXINGTON, OHIO.—The New Lexington Electric Light & Power plant has secured a ten-year contract and franchise from the city council for street lighting, at $78.82 per lamp per year, all-night service. Mr. T. J. Smith, proprietor of this plant, will make some improvements, and is in the market for supplies, poles, etc.

FREMONT, OHIO.—The Home Light & Power Company has presented an ordinance to the city council. It agrees to furnish 16-cp lamps at 50 cents per month; when six or more are used, 40 cents per month. The company will build a plant and compete with the Fremont Electric Light & Power Company if the grant is secured.

CLEVELAND, OHIO.—The American Stove Company, which has recently acquired the three leading vapor stove plants in Cleveland, will enlarge the power plant installed two years at the Dangler Stove & Manufacturing Company's plant, with a view to furnishing power for the other two large plants located not far distant. An additional boiler, engine and generator will be installed.

COLUMBUS, OHIO.—The Pennsylvania Railroad Company is making important improvements at its Columbus shops, and contracts have been closed for the following equipment, to be placed in the new power house: Three 300-kw Westinghouse direct-current generators and three 500-hp Ball & Wood vertical non-condensing compound engines. All machinery in the new shops will be electrically driven.

BEAVER, UTAH.—A franchise has been granted to E. A. Hodges to build an electric light plant here.

SALT LAKE CITY, UTAH.—The Telluride Power Company has been granted a right of way through Ogden canyon and Ogden valley, to construct an electric line east from Ogden to Logan.

SALT LAKE CITY, UTAH.—Current from the Hercules generating plant, at Logan, Utah, was turned on recently to the Telluride Company's line. This system, of 150 miles in length, now makes a complete circuit, taking power from what may be termed its two extremeties. The merging of the two companies makes it one of the first plants in the west.

RICHMOND, VA.—A very sensational turn of affairs has taken place at Richmond, in regard to city lighting. At a recent meeting of the Light Committee it was announced a new company was being formed to light the city, which company was represented by William Jenkins. It is understood that the company is backed by several millionaires, and that a million-dollar plant is being erected. The three bids presented by the Passenger & Power Company, of Richmond, were not even opened. It is said that the new company will apply for a charter. The Virginia Electric Railway & Development Company is doubling its capacity, at a cost of about $200,000.

BALLARD, WASH., adjoining Seattle, has advertised for bids for a municipal electric light plant.

WALLA WALLA, WASH.—The Mill Creek Light & Power Company has been granted a franchise in this city.

GUANAJUATO, MEX.—The Guanajuato Power & Electric Company, Guanajuato, Mexico, will begin the construction of its $1,000,000 power plant by July 1. It will start with an initial capacity of 3,000 hp, which will be increased to 7,000 as soon as needed. The distance of transmission is 110 miles. Mr. Henry Hine is president and general manager of the company.

ST. CATHERINES, ONT.—The factory formerly occupied by the Co-operative Cycle & Motor Company was sold for $10,000 to Manager William C. Bullock, of the Industrial Financial Company, which is financing the Consolidated Electric Railway, of Toronto. The new company is capitalized at $100,000, and will employ about 40 hands, to manufacture electrical appliances.

MONTREAL, QUE.—The Shawinigan Water & Power Company will use aluminum conductors for its transmission lines from Shawinigan Falls to Montreal. The distance of transmission will be about 84 miles, and the Royal Aluminum Company will supply 250,000 lbs. of wire for the first lines. Altogether 1,000,000 lbs. of aluminum will be required. The Royal Aluminum Company will establish a new plant at Shawinigan Falls for the manufacture of wire.

THE ELECTRIC RAILWAY.

SAN FRANCISCO, CALIF.—The Washington & Oregon Electric Railway, Light & Power Company has been granted a franchise for an electric railway and electric lighting in Walla Walla, Wash.

DOVER, DEL.—The Mexican Railway Construction Company, of Philadelphia, has been incorporated to operate electric railways in Mexico. Incorporators: F. Rogers Donahue, L. C. Haag, Philadelphia; Gardner W. Kimball, Wilmington, Del. Capital, $10,000,000.

KOKOMO, IND.—The Kokomo Street Railway & Traction Company has been reorganized. The new officers are: President, G. J. Marott; vice-president, L. J. Kirkpatrick; secretary and general manager, T. C. McReynolds.

RICHMOND, IND.—The Richmond & Northwestern Traction Company has been organized, with a capital stock of $50,000. The officers are: G. M. Hodges, Dayton, Ohio, president; Thos. Milliken, New Castle, vice-president, and Wm. Jessup, Richmond, secretary.

WABASH, IND.—Stockholders of the Wabash & Logansport Traction Company have elected the following officers: Dennis A. Blakeslee, New Haven, Conn., president; Fred C. Boyd, New Haven, vice-president; John S. Bradley, secretary, and Samuel C. Moorehouse, treasurer. The company will build a line from Wabash to Peru. The Logansport extension will probably be in operation about Sept. 1.

GREENSBORO, N. C.—There is a talk of a street railway to connect Greensboro, Winston and High Point.

BURLINGTON, N. C.—The Graham, Burlington and River Falls Street Railway Company has been chartered, with an authorized capital stock of $100,000. The principal office is to be at Graham, and the incorporators are: J. W. Menefee, J. A. Long and J. C. Simmons, all of Graham.

RALEIGH, N. C.—A charter has been granted to the Consolidated Railway, Light & Power Company, of Wilmington, the capital stock being $500,000—$350,000 in preferred stock. The new company is a consolidation of the Wilmington Gas Light Company, the Wilmington Seacoast Railroad Company and the Wilmington Street Railway Company.

TRENTON, N. J.—The Point Pleasant Traction Company has been incorporated with a capital of $200,000. The incorporators are: Q. N. Evans, Juan Almiral, William C. Adams, of Brooklyn, and Francis C. Chamberlain, of Point Pleasant.

MT. VERNON, OHIO.—The Mt. Vernon Electric Railway Company has secured a franchise to build an extension of its local line.

MARION, OHIO.—C. C. Stolts, a wealthy citizen of this place, is securing right of way for a line to extend from Marion to Urbana.

STEUBENVILLE, OHIO.—The Steubenville Traction & Light Company is installing a 500-hp engine and a 300-kw generator in its power station.

CINCINNATI, OHIO.—The Cincinnati Traction Company has accepted franchises granted by the councils of Norwood, Oakley and Hyde Park.

FINDLAY, OHIO.—The Toledo, Bowling Green & Southern Traction Company has awarded a contract for the erection of new car barns at Findlay.

DAYTON, OHIO.—H. Randall and other local people are securing rights of way and franchises for a line to extend from Evansville, Ind., to Boonsville.

CINCINNATI, OHIO.—Capitalists of Cincinnati and Ripley are taking preliminary steps to build a road from Ripley to Columbus, a distance of nearly 100 miles.

FREMONT, OHIO.—High winds of the past week blew trees across the tracks of the Lake Shore Electric Railway, breaking the high-tension and trolley wires and tying up the line for an entire day.

DEGRAFF, OHIO.—The Dayton & Kenton Traction Company has agreed to locate its power house and car barns in DeGraff. The town has given 25 acres of land and agreed to take $22,500 of the capital stock.

CLEVELAND, OHIO.—The Eastern Ohio Traction Company has placed a contract with the Electric Storage Battery Company, of Philadelphia, for a storage battery equipment of 400 ampere-hours capacity.

HAMILTON, OHIO.—The Cincinnati, Hamilton & Indianapolis Traction Company has been incorporated with $10,000 capital stock by J. C. Hooven, C. C. Hooven, C. E. Hooven, W. C. Shepard and S. Shaffer.

TOLEDO, OHIO.—It is reported that the Toledo, Bowling Green & Southern Traction Company has secured an option on the Toledo & Maumee Valley Railway with a view to securing an independent entrance to Toledo.

MANSFIELD, OHIO.—Citizens along the route are endeavoring to induce the Citizens' Electric Railway, Light & Power Company to extend its Mansfield-Shelby line to Plymouth, New Haven, Chicago Junction, Steuben, Fairfield and Norwalk.

BELLEFONTAINE, OHIO.—The Bellefontaine & Sidney Traction Company has been incorporated with $10,000 capital stock. Incorporators: Warren P. Freeman, William S. Defees, Robert P. Kennedy, Walter L. Plim, Frank Defrees and L. E. Pettit.

HAMILTON, OHIO.—The Hamilton, Eaton & Richmond Traction Company proposes to extend its road from Richmond east to New Castle and Middletown, connecting at the latter point with the Merchants' Traction Company's line for Anderson.

CANTON, OHIO.—Messrs Welty, Kolp and Hoover, who owned franchises for an electric railway from Canton to New Philadelphia, have sold the grant to Tucker, Anthony & Company, owners of the Akron-Canton and Canton-Massillon lines, and work of grading for the line has already been started.

CLEVELAND, OHIO.—The consolidation of the electric railway properties in the Mahoning Valley which a Cleveland syndicate has been working on for some time has been effected. The company has been chartered under the laws of Pennsylvania as the Pennsylvania & Mahoning Valley Railway Company, with a capital stock of $8,000,000. The company represents a consolidation of the Trumbull Electric Company, the Mineral Ridge Railway Company, the Mahoning Valley Railway Company, the New Castle & Lowell Railroad Company, the New Castle Traction Company, the Lawrence Gas Company and the New Castle Electric Company. The consolidation gives the syndicate something over 90 miles of road. The following-named officers have been elected: M. A. Verner, Pittsburg, president; James Parmelee, Cleveland, vice-president; John E. McVey, Youngstown, secretary; A. A. Anderson, Youngstown, general manager; B. F. Miles, Cleveland, treasurer.

KNOXVILLE, TENN.—W. T. Goffe, promoter of the Knoxville & Sevierville Electric Railway, has concluded a deal with a firm to furnish the capital for the enterprise. Work is to begin in June.

OGDEN, UTAH.—The Telluride Power Company has asked the city council of Logan to grant a franchise for the building of an electric railway between its place and Ogden.

NORFOLK, VA.—The Bay Shore Terminal Company has been granted permission to lay tracks and operate its lines to Willoughby Beach.

NORFOLK, VA.—While no positive confirmation can be secured, it is asserted at Norfolk, that the details of a street-car combination have been completed, and that the holdings of the Williams syndicate, or the Norfolk Railway & Light Company, in this city, are about to pass into the hands of Messrs. Alexander Brown & Sons, and Nelson Perrin, of Baltimore.

WALLA WALLA, WASH.—Messrs. Hellman & Romo have been granted a street railway franchise in this city.

WHATCOMB, WASH.—D. O. Mills and others of New York have been granted a street railway franchise in this place.

GRAFTON, W. VA.—Messrs. B. F. Bailey, T. E. Joyce, C. H. Straub and Eugene Somerville have applied for an electric railway franchise in Grafton. The company will be capitalized at $100,000.

MILWAUKEE, WIS.—The Central Wisconsin Traction Company has been incorporated with a capital stock of $400,000.

KENOSHA, WIS.—The Kenosha Electric Railway Company has filed articles of incorporation and will apply for a franchise.

PERSONAL.

MR. G. EMIL HESSE, M. E., has moved his office to 220 Broadway, New York. Mr. Hesse is developing a hot-air automobile, which promises success.

PROF. R. B. OWENS, of McGill University is spending the earlier part of his vacation in New York City, and will attend the Institute meeting at Great Barrington.

MR. W. TYSON GOOCH, member of the American Institute of Architects, has become associated with the engineering firm of Charles Henry Davis & Partners, of New York City.

DAVID DANIESSOE, an electrical engineer of Langsernd Wernland, Sweden, is now in the United States for the purpose of studying electric railway methods. He is at present at the Hotel Griswold, Pittsburg, Pa.

MR. O. M. LACEY, secretary of the H. G. Lacey Co., of Hanford, Calif., who is on a trip east was in New York the early part of this week. Part of his trip covered Canada, where some business relations have been established.

MR. W. G. CLARK, manager Kilbourne & Clark Co., Seattle, Washington, visited New York recently as part of a trip for the enterprising company which he represents. He reported that the business of his company had grown greatly in the past year.

MR. HAROLD ALMERT, formerly of the Chicago office of the Buckeye Electric Company has been appointed superintendent of the Cicero Light, Heat & Power Company, one of the companies supplying several Chicago surburban communities with electric light.

DEVELOPMENT OF THE SAFETY INSULATED WIRE & CABLE COMPANY.—The Safety Insulated Wire & Cable Company, of New York, a name that has always been associated with the pioneer firms of the electrical industry, as the successful manufacturer of the "Safety" seamless rubber insulated electrical conductors, has recently passed through an interesting business experience. In the financial columns of this journal there has already appeared the announcement that the Safety Company was to be re-incorporated, and that a syndicate had been formed by the well known bankers, Messrs. Zimmerman & Forshay, of 11 Wall Street, New York City, who had purchased the stock of that company, and as the re-organization has just been completed, we are now able to give the first authentic information concerning this important electrical event. The Safety Company, formerly a corporation under the New York State laws, with a capital of $250,000, is now a corporation under the laws of the State of New Jersey, where the factory is located, with an authorized capital of $1,500,000, of which $1,000,000 has been issued. The officers of the new company are Benjamin M. Whitlock, president; LeRoy Clark, Jr., and Ira W. Henry, vice-presidents; H. T. Richards, secretary; Edwin Epstein, treasurer; A. P. Eckert, assistant treasurer; A. P. Lambrecht, assistant secretary. General Whitlock, the president of the new company, was also the president of the old Safety Company. He is a member of the Union and Players Clubs, and the New York, Larchmont, and Atlantic Yacht Clubs; has a large acquaintance in social and financial circles, and is familiar with every branch of the manufacture of insulated wire and cable. Messrs. Clark, Henry, Richards and Eckert have been connected with the successful work of the old company, and Mr. Epstein represents the bankers. Mr. Leonard F. Requa, who was the principal owner of the old company, holds a large interest in the new company, and has been retained as one of the directors in an advisory capacity. The factory of the Safety Insulated Wire & Cable Co. has been in West 28th Street, New York, but its new tidewater plant is at Bayonne, N. J. It is the largest plant devoted solely to the manufacture of rubber insulated wire and cable in the country. The two main

Edwin Epstein, Treasurer. | H. T. Richards, Secretary. | B. M. Whitlock, President. | Ira W. Henry, Vice-President. | L. R. Clark, Jr., Vice-President.

OFFICERS OF THE SAFETY INSULATED WIRE AND CABLE CO.

buildings are of brick, two stories high, each having a length of 500 feet, with an aggregate floor space of 150,000 square feet. The power plant, dry rooms, etc., are in separate buildings. Several of the departments of the new factory are already in operation, and the company is completing at the Bayonne works, a large contract for submarine cable for a foreign government. This factory, being just completed, has the advantage of the latest machinery known to the art. As the property covers some thirteen acres, ample room is provided for additional buildings when required. Aside from the extensive manufacture of power, house, telegraph and telephone wires and cables, this factory has been particularly planned to meet the increasing demand for submarine cable. Its location at tide-water, with ample docking facilities, new cabling machine, recently imported from England, and a large working capital renders the company capable of producing all the above types of insulated conductors as well as submarine cable of any required length for domestic and foreign markets. The new company will be represented as formerly in Boston by F. B. Parsons; Chicago, M. B. Austin & Co.; St. Louis, Col. E. J. Spencer; Detroit, Henry L. Walker Company.

Trade Notes.

THE WOTTON ELECTRIC & MANUFACTURLING COMPANY, Atlanta, Ga., has doubled its capacity, and is now prepared to furnish alternating and direct-current loud-ringing bells.

THE VARLEY DUPLEX MAGNET COMPANY has opened a New York office at 26 Cortlandt Street. Mr. J. M. Knox, the firm's former western agent and engineer, has taken up its work in this branch office.

THE NEW HAVEN NOVELTY MACHINE COMPANY has issued a catalogue and price-list of brass fittings for telephone, telegraph and high-tension conductors. These include slidable sleeves, Y-branches and pot and terminal heads.

WATTMETERS.—C. Olivetti, Ivrea, Italy, has issued a handsome catalogue describing the various types of wattmeters of his manufacture. These wattmeters are of the registering type, and the pamphlet contains a specimen record of full size.

TELEPHONE APPARATUS.—The telephone department of the Electric Appliance Company, Chicago, has been increasing its facilities to such an extent that the company is now in shape to keep up with its orders for switchboards, telephones, and parts.

CROCKER-WHEELER CO., Ampere, N. J., has issued a very pretty little pamphlet relative to small motors and entitled "Our Bread Winners." The illustrations show a large range of its popular smaller machines and considerable data is given as to their capacity and work.

THE BRYAN-MARSH COMPANY has secured a long lease on a ground floor office at 136 Liberty Street, New York, with an entrance from 141 Cedar Street as well. It is carrying a large supply of incandescent lamps in the basement wareroom of its new quarters.

THE AMERICAN SCHOOL OF CORRESPONDENCE has made an important arrangement with the Armour Institute, of Chicago, with regard to co-operation in studies, so that the faculty of the Institute becomes a board of instruction, revision and examination for the School.

THE BURT MFG. CO., of Akron, O., recently made a large shipment of its Cross oil filters and Burt exhaust heads to Buenos Ayres, Argentine Republic. It reports an unusually active foreign demand for its goods, other shipments having been lately sent to England, Austria, Belgium, Mexico and countries in the Far East.

THE SUNLIGHT LAVA MFG. CO., Chattanooga, Tenn., through its manager, Mr. Paul J. Kruesi, is calling particular attention by announcement letter to the trade of its specialization in lava pieces for electrical purposes. Because of the constantly widening field for its material as electrical insulation, this concern is introducing considerable new equipment.

RECENT TRANSFORMER LITIGATION.—With this title the Stanley Electric Manufacturing Company, Pittsfield, Mass., has issued a folder in which a statement is made concerning the recent transformer litigation, and giving a history of the development of the S. K. C. type of transformer. The latest form of this apparatus is also illustrated and described in detail.

MR. THOMAS D. WATSON has opened an office in the Electrical Exchange Building, 136 Liberty Street, New York. He is representing and carrying a full line of knife switches, plug cut-outs, rosettes, Edison attachment plugs and other products manufactured by the Trumbull Electric Co., of Plainville, Conn., also desk, ceiling fans and incandescent lamps manufactured by the Colonial Electric Co., Ravenna, O.

THE AMERICAN INSULATING MACHINERY CO., 940 No. Third Street, Philadelphia, Pa., announces that it is closing its New England office, formerly located at New Haven, Conn., and requests that all inquiries be directed to Philadelphia. The company has been in existence but a very short period—over one year—but at the present time it has on hand actual orders sufficient to keep it steadily employed for six months to come, in addition to which, inquiries that have developed in regard to its machinery promise as much more business.

THE MACKAY ENGINEERING COMPANY, 149 Broadway, New York, is installing a 50-hp Walrath gas engine for Eimer & Amend, the New York manufacturing chemists. It has also received an order for a 73-hp three-cylinder Walrath engine direct connected to a generator, for Tokio, Japan. The same company is installing an Akron 400-kw lighting and power plant in the New York and Brooklyn establishments of the Trow Company, two 50-kw Akron units for the Ordnance Department of the New York Navy Yard, and two 50-kw Akron units for the Construction and Repair Department of the same yard.

PARAGON FAN & MOTOR CO., of 572 First Avenue, New York City, have just issued a bulletin devoted to their Paragon sewing machine transmitter for direct and alternating current to go with their small motors for use on apparatus of such size. With this transmitter, the machine head is driven positively at all times; and the variable speed is obtained by means of a variable leverage, so that any degree of work is obtainable by allowing the machine to operate at a sufficiently low speed. These ingenious and satisfactory appliances are made in two sizes for both classes of current, and can be readily attached to any well known sewing machine. The bulletin gives full details about them and about the motors.

SUPERHEAT AND SUPERHEATERS.—With this title the Cruse Controllable Superheat Company, 5 Blackfriars St., Salford, Manchester, England, has issued a model pamphlet descriptive of the superheating apparatus of its manufacture and on the principles of superheating. The first division of the pamphlet consists of a thorough treatise on the principles of superheating, following units, thermometer scales, specific heat, etc., which includes a large number of tables on the properties of saturated steam, factors of evaporation, etc. The description of apparatus is accompanied by a number of large folding sheets of engravings, showing in detail the "Controllable Superheater and Dry Steam Generator."

CONTRACT FOR CONDUIT.—The firm of C. J. Harrington, 15 Cortlandt Street, New York, has received a contract for 250,000 feet of conduit, to be shipped to Seattle for Stone & Webster, Boston, Mass. There are other large contracts in view. This firm has but recently taken up the management of the sales for the Scranton Fire Brick & Conduit Co., Scranton, Pa., and is doing an unusually large business in this line, and the indications are that they will become one of the largest dealers in conduit in the country. The inquiries have come in so fast that it has been almost impossible to give them the proper attention, but the firm is now ready to furnish conduit very promptly and at low prices. Parties using conduit would do well to consult this firm before closing contracts. The conduit has been tested by one of the most expert electrical engineers in New York and pronounced to be of the very best quality he ever saw.

HUNT APPARATUS AT MANILA.—The U. S. Government, having selected Sangley Point in Manila harbor for a coaling station, extensive wharves and fire proof buildings are being erected there, including two coal sheds each 194 feet wide and 500 feet long with an interval of 50 feet between them, and a wharf is 318 feet in length and 75 feet wide. The coal handling machinery has been designed to remove the coal from colliers by means of hoisting towers and distribute it in the storage sheds by automatic railways; also to coal the war vessels at the wharf from the shed. To do this to best advantage, required two steeple towers, equipped with steam hoisting engines and duplex steam shovels, twelve automatic railways and over a mile of track. All this coal handling machinery together with accessories such as railway equipment, cars, coal tubs, etc., is being built by the C. W. Hunt Company, New York. Recently thirty-six flat-top, four-wheel cars were completed and shipped to the Philippine Islands. Each car is of one-ton capacity to be used on the Hunt Industrial Railway. Standard gauge for this railway is 21½ inches, out to out of rail heads, and is admirably adapted for transporting material on wharves, warehouses, docks and shops.

Record of Electrical Patents

[Conducted by Wm. A. Rosenbaum, Patent Attorney, 140 Nassau St., New York.]

11,997. INSULATED CONDUCTOR; E. Thomson, Swampscott, and J. G. Callan, Lynn, Mass. App. filed March 11, 1902. An insulating compound consisting of an adherent non-explosive cellulose ester attached to a support.

700,619. ELEVATOR SIGNAL DEVICE; S. D. Collett, New York, N. Y. App. filed Feb. 10, 1902. Apparatus to enable the elevator "starter" to communicate with the attendant in any car after it has left the starting floor. (Issued May 20.)

700,763. TROLLEY CATCHER; A. W. Ham, Lansingburg, N. Y. App. filed Oct. 23, 1901. A winding drum controlled by pawl and ratchet.

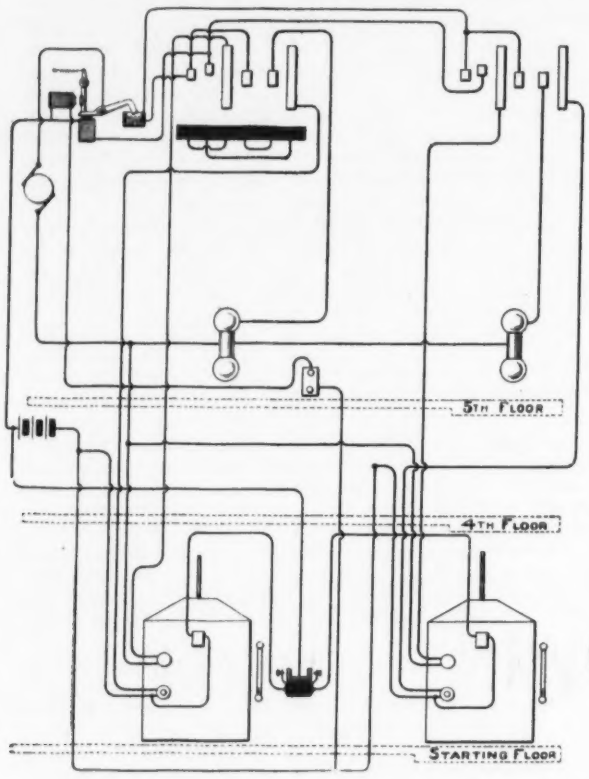
700,783. GALVANO ELECTRIC THERAPEUTIC CHAIN; A. Kruger, Stettin, Germany. App. filed March 19, 1902. The links of a chain are made in two parts forming the couples of a cell, there being moisture absorbing material between them.

700,800. MULTIPLEX TELEGRAPH CIRCUIT; L. A. McCarthy, Brooklyn, N. Y. Nov. 18, 1901. The object is to combine the receiving instrument and controlling device at one end of a quadruplex circuit, such as shown in patent No. 693,530, with shunting magnets so arranged that the incoming current will not be able to interfere with the resistance of the artificial line, and thereby throw the receiving instrument out of balance.

700,808. ELECTRIC FURNACE; W. R. Parks, Chicago, Ill. App. filed July 22, 1901. (See page 1014.)

700,812. ELECTRIC ALARM; G. M. Peyton, Salt Lake City, Utah. App. filed June 1, 1901. A permanent magnet in the sash normally holds a circuit open, but when moved allows a spring to close the alarm circuit.

700,839. MAGNETIC CLUTCH; F. L. Sessions, Oakpark, Ill. App. filed Sept. 9, 1899. A free rotating part between two other rotating parts are provided with pole pieces and two stationary coils are arranged so that when one coil is energized, the freely rotating part will move in one direction, and when the other coil is energized it will move in the other direction.



700,619.—Elevator Signal Device.

700,847. REGULATOR FOR ALTERNATING CURRENT CIRCUITS; C. P. Steinmetz, Schenectady, N. Y. App. filed Aug. 16, 1897. (See Current News and Notes.)

700,851. AUTOMATIC SIGNAL; R. L. Storm, Waterloo, Iowa. App. filed July 25, 1901. A register having a dial, shows to the motorman how many cars have entered a block ahead of him.

700,869. ELECTRODE; K. A. Wilde, Glinde, Hamburg, Germany. App. filed Sept. 22, 1900. A flat electrode for secondary batteries comprising a carrier provided with substantially helical grooves for the active material.

700,898. ELECTRODE FOR ELECTRIC ACCUMULATORS; E. J. Clark, Stratford, Eng. App. filed Jan. 6, 1902. The plate is made up of a series of horizontal gutters into which the active material is deposited.

700,912. SIGNALLING AND TELEPHONING APPARATUS; E. L. Grauel, Carthage, N. Y. App. filed Jan. 24, 1902. (See Current News and Notes.)

700,915. METALLIC YARN AND TEXTILE FABRIC; L. Harmel, Boulzicourt, France. App. filed April 9, 1901. A fabric adapted to produce voltaic action in which electro-positive and negative wires are interwoven with the textile material.

700,941. PROCESS OF TREATING COPPER OR OTHER ORES FOR OBTAINING THEIR CONTENTS OF METALS; N. S. Keith, Arlington, N. J. App. filed Dec. 7, 1901. (See page 1014.)

700,980. ELECTRIC SAWING MACHINE; C. Partington, Newport, Ky. App. filed Nov. 2, 1901. The saw and feeding mechanism are driven by independent motors, so that the saw can be driven at a very high rate of speed and quickly controlled.

700,989. AUTOMATIC FUSE SWITCH FOR TELEGRAPH OR OTHER CIRCUITS; C. A. Stimpson, Philadelphia, Pa. App. filed Aug. 28, 1901. The destruction of one fuse allows an arm to automatically complete a second circuit containing a second fuse, and thus avoid delay in the service.

701,012. RHEOSTAT; R. W. Brown and C. A. Rhine, Milwaukee, Wis. App. filed Dec. 16, 1901. Details of construction.

701,016. ELECTRIC ARC LAMP; J. L. Davies, Highburg, Eng. App. filed Jan. 15, 1901. Consists of the means for attaching the coils to the frame work, improvements in the frame work and improved means for counter-balancing the cores of the regulating coil.

701,032. LIGHTNING ARRESTER FOR OVERHEAD WIRES; G. Gola, Genoa, Italy. App. filed Dec. 10, 1901. (See Current News and Notes.)

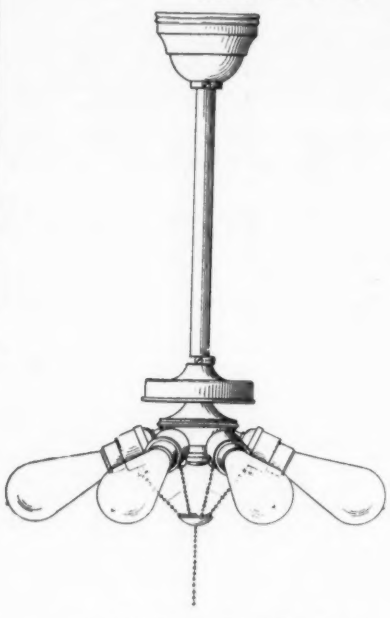
701,063. INSULATOR PIN; F. M. Locke, Victor, N. Y. App. field Nov. 15, 1901. The upper end of the pin is provided with barbs; the insulator knob being of wood.

701,085. TROLLEY WHEEL; J. Preston, Joliet, Ill. App. filed Jan. 29, 1902. The wheel is hung on cone bearings between two pivoted arms of a harp.

701,114. COUPLING AND NIPPLE FOR OUTLET OR JUNCTION BOXES; M. F. Whiton, Hingham, Mass. App. filed Feb. 3, 1902. The outlet box is formed with other than round holes, so that the end of the conduit can interlock with the box by twisting it in the hole.

701,122. COMBINED LIGHTNING ARRESTER AND BINDING POSTS; E. E. Yaxley, Chicago, Ill. App. filed March 13, 1901. A post having an opening for a carbon pencil and also an opening for the wire and for the screw which holds it in place.

701,137. INTERIOR CONDUIT OUTLET BOX; W. F. Bossert, Utica, N. Y. App. filed March 25, 1902. The outlet box is adjustable so that the lamp bracket can be adjusted to any angle with the wall.



701,269.—Switch Cluster Operating Device.

701,152. TELEPHONE SYSTEM; H. P. Clausen, Chicago, Ill. App. filed April 26, 1901. (See page 1015.)

701,185. ELECTROTHERAPEUTIC APPARATUS; G. W. Euker, Richmond, Va. App. filed Feb. 26, 1902. Relate more especially to the converting and controlling of alternating currents of high pressure such as are usually furnished for commercial use, and rendering the same available for therapeutic purposes.

701,208. CABLE CONNECTION; C. Luke, Milford, Conn. App. filed Jan. 16, 1902. The lead cover is interrupted by a water-tight gland which surrounds a joint in the conductor.

701,209. COVERING MEANS FOR JOINTS IN ELECTRIC CABLES; C. Luke, Milford, Conn. App. filed March 10, 1902. Similar to the preceding, except that the gland is filled with an insulating material.

701,210. CABLE CONNECTION FOR COVERING SPLICED JOINTS; C. Luke, Milford, Conn. App. filed March 10, 1902. Details of construction of a joint similar to the past preceding.

701,215. METHOD OF OBTAINING ZINC BY ELECTROLYSIS; L. Mond, London, Eng. App. filed Aug. 12, 1901. (See page 1014.)

701,216. APPARATUS FOR OBTAINING ZINC BY ELECTROLYSIS; L. Mond, London, Eng. App. filed March 4, 1902. (See page 1014.)

701,218. ELECTRIC FURNACE; F. Morani, Rome, I[illegible]. App. filed July 24, 1900. (See page 1014.)

701,246. INSULATOR PIN AND BRACKET; E. [illegible]. Baily, Mount Kisco, N. Y. App. filed March 25, 1902. The pin is formed in two parts fashioned to be forced into contact with the holding support by the application of the insulator.

701,247. TROLLEY; W. L. Baker, Painesville, O. App. filed Jan. 20, 1902. The shaft of the wheel is set in elongated holes in the harp, which permit it to tilt.

701,253. BATTERY; G. S. Bennett, San Francisco, Cal. App. filed Aug. 6, 1901. A cell made up of alternate disks of copper, zinc and absorbent material, strung upon a central rod and all inclosed in a sealed case from which the terminals project near the center.

701,269. SWITCH CLUSTER OPERATING DEVICE; H. Hubbell, Bridgeport, Conn. App. filed Sept. 4, 1901. One chain or cord collects with all of the sockets of a cluster by other chains branching therefrom, so that a pull on the first chain will move the switches of all the lamps at once.

701,275. AUTOMATIC SIGNAL FOR ELECTRIC RAILWAYS; R. L. Storm, Waterloo, Iowa. App. filed July 25, 1901. Details.